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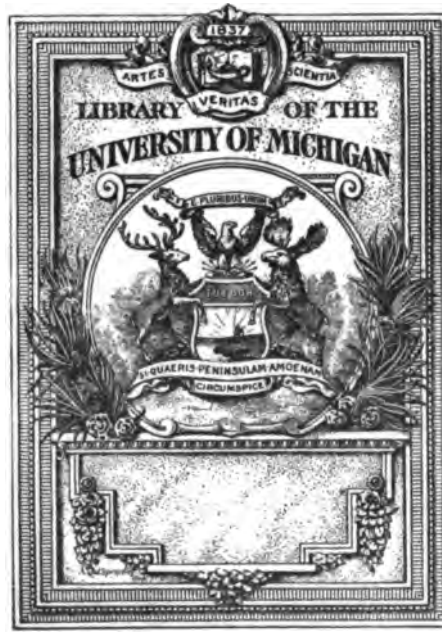
and

PHOTOMECHANICAL PROCESSES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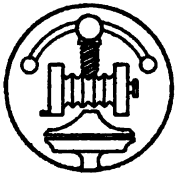
PHOTOGRAVURE.
Portrait of the Author.

HORGAN'S HALF-TONE AND PHOTOMECHANICAL PROCESSES

By STEPHEN H. HORGAN



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PREFACE.

It was the writer's fortune to witness the culmination of what may be termed the Golden Age of Wood Engraving in the United States; to be present at the birth of photo-engraving; to have taken an active part in the struggle for supremacy between wood engraving and photoengraving; to regretfully witness the decline of wood engraving, and to contribute somewhat to the success and popularizing of what is now included in the generic term, "Processwork." Now that manual engraving has surrendered and photo-mechanical engraving occupies the field, it has been suggested that the writer put on record some of the knowledge gained through his unique experience.

The contest began with the appearance of the first illustrated daily newspaper in the world. This was on March 4, 1873, when the New York *Daily Graphic* issued its first copy. Artists, engravers, publishers, printers everywhere were startled by the boldness of what they thought was but an experiment. Still the *Graphic* lived for eighteen years. It raised up a school of illustrators that became pioneers in the newer methods, and taught that the camera was the future medium for introducing illustrations to the printing-press.

In 1874 the writer was initiated into the mysterious chambers where the *Graphic* processes were worked behind locked and barred doors. From that day his life has been given to the study of all the methods by which photography could be applied to producing pictures in printing-ink. Many of these methods he has put into practice.

During the past eighteen years it has been the writer's pleasure to contribute from his storehouse of experience to those who ask for information regarding the photomechanical printing processes, through the columns of THE INLAND PRINTER. Reciprocity has resulted. There has been an interchange of knowledge, and he has learned, among other

things, what are the subjects, relating to processwork, on which there is most frequently a demand for light.

These queries came from the journeyman engraver as well as the apprentice; from artists, employing engravers, publishers, printers, advertisers, investors of capital and the varied classes who read THE INLAND PRINTER. So one object of this book has been to combine in one volume, in a brief way, the information most desired.

Nothing theoretical is recorded. All the processes and formulas as given have been evolved by practical use. Many of them have cost a fortune, together with years of experiment, to develop. They follow in the book in something like the order in which they came into use. Preference has been given to the methods that have survived, those that have proved entirely practical and are either in use to-day or are merely awaiting application. An account of the photomechanical printing processes that have been tried and found wanting would fill many volumes, yet some space has been given to them here for the reason that many of them are being rediscovered by beginners at processwork. These tyros, thinking they have an important discovery, interest capital only to find later, after much waste of energy and money, that they are trying to resurrect a corpse.

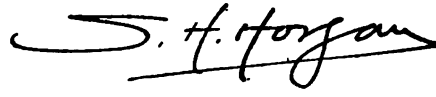
If the student of processwork will begin with photolithography and master that process he will possess a knowledge of the underlying principles in all of the photomechanical printing methods and particularly as regards negative-making, which, after all, is the basis for good processwork of any description. The index will guide the reader to the information he is seeking, and the perplexed processworker to a way out of his troubles; while a study of the illustrations, with a magnifying glass, will enable any one to learn to distinguish the varied processes that contribute the pictures which illuminate printed matter to-day.

Gratitude is herewith expressed to those who so willingly contributed the splendid educational exhibits of their work. These illustrations were not selected for their attractiveness (the pictures of the gentle sex, of course, excepted), but for

their technical value, which will be appreciated by the student. Wood, steel and wax engraving; needle-point etching, mezzotint, aquatint and the manual methods of engraving are of course omitted because photography does not necessarily enter into their production.

As to the future of processwork — there is no one sufficiently prophetic to predict it. It is conceded that it has been one of the principal factors in popularizing the product of the printing-press, thus spreading knowledge and hastening progress. It has also created enormous lines of new business, introduced special kinds of paper, ink, and much improved presses. The exhibits of the offset press and rotary photogravure in this volume point in the direction of future conquests. That it is destined to wider, better, higher achievement is inevitable, as Tennyson's lines come to mind:

> Not in vain the distance beacons. Forward,
> Forward let us range;
> Let the great world spin forever down the
> Ringing grooves of change.
>
> Yet I doubt not through the ages one
> Increasing purpose runs,
> And the thoughts of men are broadened by
> THE PROCESS OF THE SUNS.



CONTENTS.

THE ILLUSTRATIONS IN THIS VOLUME

AND

THE ENGRAVERS AND PRINTERS TO WHOM CREDIT IS DUE FOR THE EXHIBITS OF PHOTOMECHANICAL PRINTING PROCESSES.

AUTOCHROME REPRODUCTION IN THREE PRINTINGS.

This is "the last word" in reproducing in printing-ink the colors of nature. And it is most appropriate that the subject of the picture should be M. Louis Lumière, one of the famous brothers of Lyons, France, to whom the invention of the Autochrome system of photography in colors is due. The reproduction of the autochrome into three printing-plates, as well as the printing, is by J. HORACE MCFARLAND, of Harrisburg, Pennsylvania.

BOOK STAMPS FOR THE COVER.

Here is a little-known application of photoengraving. The halftone screen enlargement, used as a band around the cover, and the lettering in gold, were stamped from brass plates one-quarter inch in thickness. The designs were photographed upon the brass plates when sensitized with an enamel. They were etched in an etching machine. These plates are known as book stamps for hot-press work, and are a specialty with THE PHOTO-CHROMOTYPE COMPANY, of Philadelphia, who supplied them.

COLLOTYPE.

"Bed Time Stories" was printed direct from gelatin on a steam press by the AUTOGRAVURE COMPANY, of New York. This process, while equaling a photograph in quality, has the advantage that it is printed in a permanent printing-ink. It is one of the photomechanical printing processes much neglected by publishers through want of knowledge of its possibilities. A chapter on Collotype will be found on page 41.

COMBINATION PLATE.

Scenes recalling Paul Revere's famous ride are contributed by the FOLSOM & SUNERGREN COMPANY, of Boston. The border and the several scenes inserted in it were photographed from different copies and the negatives combined in one plate, hence the name "Combination Plate." Paul Revere was the earliest American engraver and the first one to roll copper into sheets, so that he is a sort of patron saint of American engravers.

"DIRECT PROCESS" WITH NORWICH FILM.

This is an extremely simple engraving method by which the drawing of the artist can be used as a positive for intaglio engraving or turned into a negative for relief engraving or planographic printing. This engraving was made by the inventor, OZIAS DODGE, of Norwich, Connecticut. The process is described on page 189.

DUOGRAPH, WITH MEZZOGRAPH SCREEN.

The portrait of "A Sweet Girl Graduate" is printed from a half-tone with a mezzograph tint-plate. The grain of the mezzograph screen underneath breaks up the mechanical character of the screen half-tone with a most pleasing result. This style of engraving is not in use to the extent it should be. These plates are from GATCHELL & MANNING, Philadelphia, Pennsylvania.

DUOGRAPH.

The portrait of Louis J. M. Daguerre, who gave to the world the Daguerreotype process, January 9, 1839, is from a daguerreotype made in 1846. Here are shown two half-tone plates made at different angles to each other and the two printings superimposed. The plates are from one of the oldest photoengraving firms in America, the ELECTRO-LIGHT ENGRAVING COMPANY, of New York.

FIRST PHOTOENGRAVING.

This portrait of Cardinal d'Amboise is famous through being the earliest photoengraving known. The plate was engraved, through the aid of bitumen or asphalt, by Joseph Nicephore Nièpce, in 1824. The original plate is still in the museum at Chalons, France. An impression from the original plate is in the Smithsonian Institution, Washington. It was reproduced by Mr. Albert H. Walker, of New York, and from the latter THE BARNES-CROSBY COMPANY, of Chicago, produced the marvelous reproduction shown here. This company specializes in every branch of processwork, so that this plate may be said to be the acme of relief-plate line engraving. Every detail and defect in the reproduction of Nièpce's engraving is faithfully preserved.

FOUR-COLOR PROCESS BLOCKS.

"An Engraver," from the picture by Paul Mathey in the Musée du Luxembourg, Paris. This most beautiful reproduction in colors is worthy of careful study with a microscope. It will be noticed that the screens used are 160 lines to the inch. The blue plate is

from a single line screen with the lines running vertically; the red is also made through a single line screen with the lines horizontal. The yellow plate is from a cross-line screen with one of the lines printing at an angle of 22½ degrees, while the gray, or black plate, is also from a cross-line screen printed at an angle of 45 degrees. These color blocks were engraved expressly for this volume by JOHN SWAIN & SON, LTD., London. See "Three-color Process-work," page 111.

HALF-TONE OF 1868.

The original steel-plate engraving, from which this is enlarged almost twice, was made by Gen. Frederick W. Von Egloffstein at 125 West Twenty-fifth street, New York, in 1868. It will be noticed that a wavy-line screen was used. The excellent reproduction is by F. A. RINGLER COMPANY, New York.

HALF-TONE WITH TWO-HUNDRED-LINE SCREEN.

The latest portrait of Mr. Frederic E. Ives, by the SUFFOLK ENGRAVING COMPANY, of New York and Boston, is appropriately enough made with the finest screen that can be successfully used in printing. Mr. Ives has contributed more than any other individual to make practical the half-tone screen and its method of use employed to-day. The "Half-tone Process" is described on page 85.

HIGH-LIGHT HALF-TONE.

The WALKER ENGRAVING COMPANY, of New York, exhibit here the highest point that photoengraving has reached at this time. This high-light half-tone was made from a drawing by Vernon Howe Bailey, copyrighted by Harper & Bros. Every processworker will appreciate the delicacy of the engraving and the vignetting. High-light half-tone negative making is described on page 144.

HIGH-LIGHT HALF-TONE OF 1880.

The writer began experimenting with half-tone in 1876. Though with little time at his disposal, he devised a practical half-tone process which was first shown in the New York *Daily Graphic*, of March 4, 1880, with a picture titled "Shanty Town." The endeavor in those days was to get a "full-tone," that is, a picture graded from solid blacks in the deepest shadows to pure whites in the extreme high lights, for the reason that there was no coated paper in those days and the presses and printers had not arrived to print half-tones as experience has taught to-day. The half-tone here shown was made in February, 1880, and the excellent reproduction of it was made by the GENERAL ENGRAVING COMPANY, of New York.

LINE PHOTOENGRAVING.

This most important branch of photoengraving has been neglected since half-tone engraving has become so popular. The illustration is a suggestion for a statue to Gen. William T. Sherman, by James E. Kelly, the sculptor. Mr. Kelly it was who first introduced outline drawing to the magazines of this country. The reproduction of his most delicate sketch is by the GLOBE ENGRAVING & ELECTROTYPING COMPANY, of Chicago. A chapter is given to "Relief-line Engraving," beginning page 69.

MEZZOGRAPH.

A portrait bust of Joseph Nicephore Niépce, the first photoengraver. Niépce was born at Chalon-sur-Saone, March 7, 1765, and died July 5, 1833. Discovering that asphalt was sensitive to light, he made, in 1822, photographic prints upon tin with it. In 1824 he made the first camera picture. His first photoengraving was also made this year, a reproduction of which is given in this volume. This mezzograph engraving was made by the CINCINNATI PROCESS ENGRAVING COMPANY, of Cincinnati. Paragraphs treating on the mezzograph screen will be found on page 186.

NEGATIVE ETCHED ON GLASS.

On page 183 is described the method of etching negatives with needle points. The portrait, made from an etched negative, is that of the Hon. Charles O'Conor, from the New York *Daily Graphic*, of June 26, 1873. Charles O'Conor was New York's leading lawyer and is said to "have never lost a case." The reproduction testifies to the skill of the FARMER-ZEHR ENGRAVING COMPANY, of New York.

NEWSPAPER HALF-TONE.

THE AMERICAN PRESS ASSOCIATION contributed the exhibit of the best there is in newspaper illustration to-day. The writer founded, in 1884, the art and engraving departments of this association, and when the history of illustrated journalism comes to be written it will be found that this department pioneered and set the style for modern newspaper illustrations in America, and consequently for the whole world.

OFFSET PRINTING IN COLOR.

The beautiful insert showing a girl of the period proves the infinite possibilities of the offset press in rendering color effects. This has the quality of the pastel. It is accomplished in nine printings and is called an "aquatint" by THE KNAPP COMPANY, New York, who supplied the inserts. The chapter on "Photoplanography,"

on page 133, describes the application of photography to the offset press.

OFFSET-PRESS WORK IN ONE PRINTING.

GIES & Co., of Buffalo, have given one of the best answers to the critics of the offset press in this beautiful insert which they have supplied, showing impressions on both sides of rough-surfaced paper. It proves that the success of the offset press depends upon the "man behind the gun," and the GIES COMPANY have picked gun crews. The softness and delicacy of gradation of tones shown here will be a revelation to many. See "Photoplanography," page 133.

PHOTOELECTROTYPE.

With our increased knowledge, improved lenses and processes, it is doubtful whether we could improve on this photoelectrotype portrait of Mr. F. A. Ringler. This portrait is printed from an electrotype made about 1890. The process is well described on page 63.

PHOTOGRAVURE.

The frontispiece was made by MR. W. H. GILBO, of Brooklyn, New York, a pioneer in engraving photogravure plates in the United States. When the illustrations printed on coated paper have all crumbled to dust in this volume, the photogravure will be still in good condition. It is a reflection on the taste of the American public that photogravure is not more popular. On page 47 will be found a chapter devoted to "Photogravure."

PHOTOLITHOGRAPHY.

The map photolithographed by LEGGO BROS. & Co., of New York, and printed by CHARLES HART, lithographer, also of New York, will be a surprise to those who are unacquainted with the beauties of this oldest of the practical photomechanical processes. There is no engraving, routing, underlaying or overlaying on this work. It is an exact reproduction of the artist's drawing. The map is from "A Text Book on Plain Lettering," by courtesy of the author, Prof. Henry S. Jacoby, of Ithaca, New York. The opening chapter in our volume, page 11, goes into the details of photolithography for the first time.

FIRST PHOTO-RELIEF ENGRAVING.

Paul Pretsch patented in England, on November 9, 1854, his process for making printing-plates from gelatin swelled into relief. He sensitized the gelatin with nitrate of silver, iodid of potassium and bichromate of potash, and reticulated the gelatin afterward with a solution of tannin in alcohol. He then either cast in plaster and

made a stereotype or electrotyped to get a printing-plate. Our exhibit is reproduced from the *Photographic Journal*, of November 15, 1860, by the RANSOM ENGRAVING COMPANY, LTD., of Winnipeg, Canada.

ROTARY PHOTOGRAVURE.

THE ROTARY PHOTOGRAVURE COMPANY, of Passaic, New Jersey, furnish the beautiful insert showing "A Road Through the Pines." The softness and lack of mechanical grain of any kind grows on one the longer the picture is studied. This photomechanical printing method is only just arriving and is explained for the first time on page 145.

ROTARY PHOTOGRAVURE IN COLORS.

This may be called the twentieth century process, for it is only in its infancy. As will be noticed by the beautiful insert, it retains all the character of the water-color or pastel original. The soft paper on which it is printed gives it an added charm. The results are had in four printings. This is one of the methods which promises the greatest future development. THE VAN DYCK GRAVURE COMPANY, of New York, supplied these inserts through the courtesy of the NATIONAL ART COMPANY, also of New York. See pages 111 and 145 for description of rotary photogravure.

SWELLED-GELATIN PROCESS.

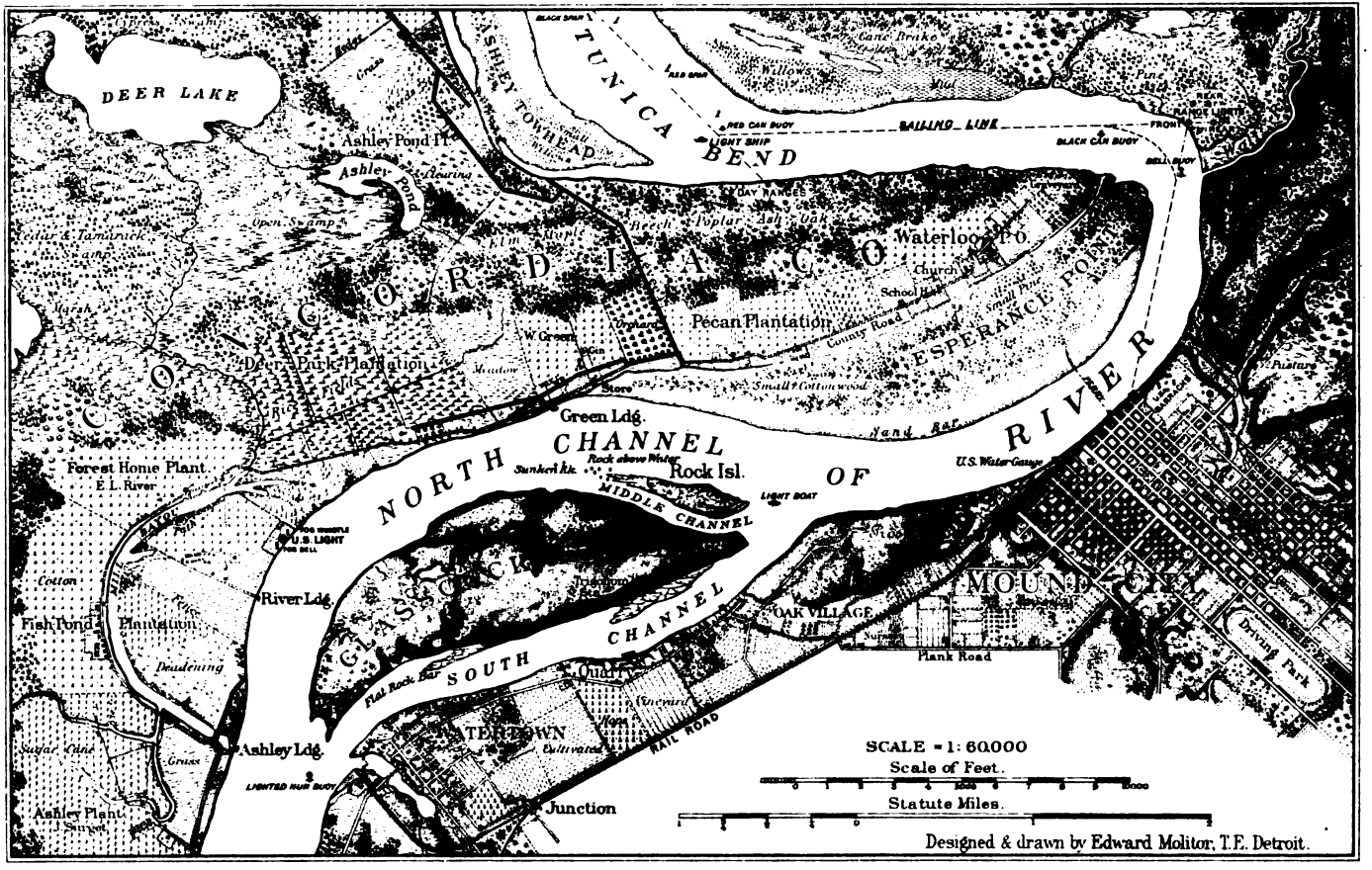
The splendid results which John A. Moss obtained through his swelled-gelatin process is shown through an electrotype of one of his plates made about 1876. The original is in the possession of the AMERICAN TYPOGRAPHICAL LIBRARY AND MUSEUM, Communipaw, New Jersey. Moss' method is told for the first time on page 61.

THREE-COLOR PRINTING.

The success of the ZEESE-WILKINSON COMPANY, of New York, in three and four color reproduction is too well known to need mention here. Their "Dutch Milkmaid" is a marvelous result in three printings. Having specialized in colorwork, they have mastered its intricacies. Three-color blockmaking is on page 111.

WAVY-LINE HALF-TONE.

JOHN SWAIN & SON, LTD., contribute a portrait of Miss Gertrude Robins, made by a modification of the Dargavel wavy-line screen. It will be noticed that the shadows are strengthened by a straight-line screen effect. Though the screen used on this portrait is but sixty lines to the inch, it is far more pleasing than if made with a cross-line screen of the same pitch.



PHOTOLITHOGRAPHY

APPLIED TO

PLANOGRAPHIC PRINTING FROM ZINC, ALUMINUM, STONE, OR THE OFFSET PRESS.

Photolithography, or the application of photography to lithographic printing, was the first of the photomechanical reproductive processes to be commercially profitable. It was the basis of a big business in New York when, in the eighties, it was crowded out by the photorelief processes that came into use at that time. Had the offset press then been perfected, photolithography would have been applied to the offset press, and would have continued to be the most practical method for reproducing maps, diagrams, charts, catalogues, and much of the illustrative matter of to-day in which the high lights are desired to be clear as in lithography. For it must be remembered that the principle of the offset press is that of lithography.

THE OFFSET PRESS REVIVES PHOTOLITHOGRAPHY.

The offset press has revived a demand for photolithography, or for a method of securing illustrations by photography on the grained zinc plates used on the offset press. Photolithography in the old days was practiced in secret, and the few who were best acquainted with the methods have passed away and their secret processes have been buried with them.

The present writer having been superintendent of the largest photolithographic establishment on the American continent and having devised the photolithographic process that was used so successfully there for about eighteen years has been requested to describe here for the first time the methods he used on the *New York Daily Graphic,* the first illustrated daily newspaper in the world.

THE FATHERS OF PHOTOLITHOGRAPHY.

It is of interest to note here that the first experiments in photolithography were made simultaneously in 1841 by Dixon

in this country and by Lewis in Ireland. Zurcher followed in 1842 in Paris. Ten years later Lemercier, Lerebours and Davanne began in France to use the asphalt process on stone. In 1855 Poitevin, of Paris, patented the first practical photolithographic process. In 1858, Cutting & Bradford, of Boston, patented another process, and then came the most practical process of J. W. Osborne, of Melbourne, Australia. The rights for the United States for Osborne's process were secured by the American Photolithographic Company, of New York, and thus began in the seventies the use of photolithography for reproducing Government maps, Patent Office drawings, and the reproduction of steel engravings which were so popular for home decoration at that time.

The publication of the first illustrated daily newspaper in New York on March 4, 1873, startled the whole printing world, for it demonstrated that photography was going to usurp the place of wood engraving, which at that time was the only method of preparing illustrations for the printing press. So carefully were the secrets of the *Daily Graphic* guarded that the writer was under heavy bonds not to divulge even what he saw in their extensive photographic department. In two years the writer had devised a photolithographic process of his own, which was the one afterward used on the *Daily Graphic*.

ADVANTAGES OF THE "GRAPHIC" PROCESS.

The advantage of this "Graphic" process, as it was called, was its simplicity, the great speed with which pen drawings and pencil sketches could be gotten to press. No reversed negative or routing was required. No overlaying or underlaying on the press, and still the daintiest vignettes were printed with the softest of edges. Any number of duplicate transfers could be made for the many presses required, and the additional feature was the inexpensiveness of the process. From cost records of a year on the *Daily Graphic*, it was found that photolithographic transfers, ready for transference to stone, did not cost a quarter of a cent a square inch.

The drawback to the process was the slowness of the lithographic presses of those days. They would print only about 700 to 800 an hour. The *Daily Graphic* was an eight-page paper, the pictorial four pages were printed first lithographically and the inside four pages were run off from type on a four-cylinder " turtle " press.

The *Daily Graphic* newspaper was but an advertisement for the other business, which included the *Patent Office Gazette;* reproductions of the regular weekly issues of patent drawings, Government and real-estate maps; art reproductions; catalogues; booklets; cigarette and other labels; book illustrations, and several weekly newspapers. The quantity of illustrative work that went through the *Graphic* establishment could not be handled by any of the photoengraving plants of our day.

And still the methods of the *Daily Graphic* are entirely feasible to-day, with the advantage that through the use of the offset press they can be made more profitable.

REQUIREMENTS IN THE PHOTOPLANOGRAPHIC PROCESS.

To make plain the requirements of the ideal photolithographic — or as we have now changed the printing surface from stone to metal, we can term it the photoplanographic process — it should be said that there are several ways of getting an image by photography on metal ready to print from. One is by transfer, another by photoengraving intaglio and transferring from the intaglio plate, and lastly photoprinting direct on the metal. The production of a transfer direct on paper by photography we shall still call photolithography and getting the design direct on the metal by photography will be termed photoplanography.

THE IDEAL PHOTOLITHOGRAPHIC TRANSFER.

The most perfect transfer that a lithographer handles is the one pulled from an engraving made for the purpose on stone. This transfer is sharp and has the proper amount of transfer ink, of the right consistency to make the best possible transfer to stone or metal for the offset press. A photo-

lithographic transfer can be made to approach this ideal transfer. The lines and dots on it must be sharp, with a full body of transfer ink of the proper degree of hardness. The paper support must be thin, tough, and have enough sizing on it to prevent the transfer slipping in transferring. And here is where all the published methods of photolithography fail, the paper coating recommended contains too soft or too heavy a gelatinous coating which causes the lines to smash in transferring.

After years of daily experiment with all the various gelatins in the market, and with all possible combinations of gelatin with albumen and gums for photolithographic purposes, the writer has found the following simple formula to approach nearest the ideal method.

THE PAPER TO USE.

The best paper to use as a support for the coating on which the transfer is made is the pure linen paper known as "Saxe" and "Rives." It should be the genuine paper. There is an imitation paper sold under these names that must not be considered. This paper comes 18 by 22 inches in size and in weight about ten kilos (twenty-two pounds) to the ream. It should be coated with the following solution.

SENSITIZING SOLUTION FOR TRANSFER PAPER.

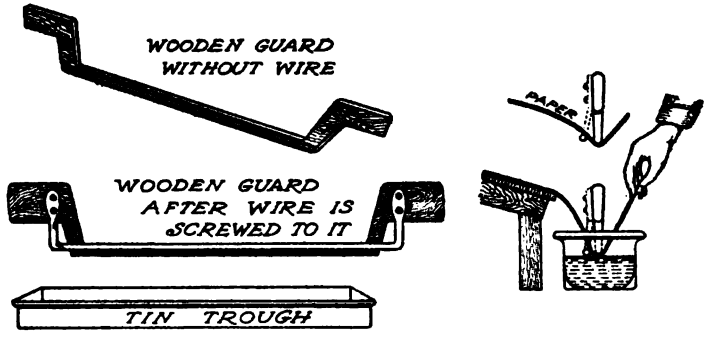
Nelson's Sparkling Gelatin.....	160 grams	5 ounces 69 grains
Water	1,000 grams	31¾ ounces
Bichromate of potash.....	100 grams	3¼ ounces
Acetic acid, 30% pure.....	50 grams	1 ounce 6½ drams
Chrome alum	1 decigram	1½ grains

The process is all very simple and is certain of perfect results, providing the following instructions are carried out in the preparation of the above sensitizing solution and the method of applying the coating to the linen paper.

PREPARATION OF THE SENSITIZING SOLUTION.

Nelson's sparkling gelatin, like all gelatins, contains a trace of grease, which must be removed or it will appear as minute round bare spots where the gelatin does not cover the

paper. To get rid of any possibility of grease in the coating the 160 grams of gelatin must first be put to soak in the one thousand grams of water until it has absorbed all of the water, then the albumen of two eggs is stirred into the gelatin. The soaking of the gelatin had better be done in one of those stoneware breakfast-food cookers consisting of two vessels fitting one inside the other. The lower vessel contains water which boils over heat, while in the upper vessel is placed the gelatin to dissolve while the albumen is well stirred in. The upper vessel is then covered and the gelatin and albumen allowed to "cook" for half an hour, or until the albumen appears to be coagulated and is floating with other foreign matter on the surface of the heated gelatin. Strain the gelatin while hot through a muslin bag into a glazed pitcher or an enameled-ware vessel.



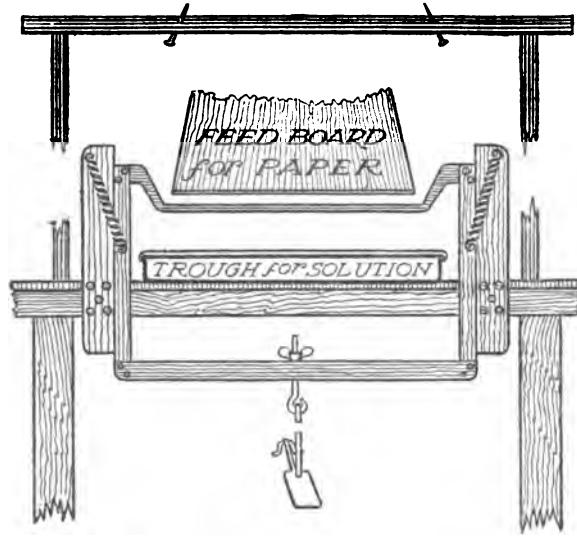
SIMPLE APPARATUS FOR COATING PAPER.

Gelatin is exceedingly sensitive to chrome alum. The slightest trace of the alum has a hardening effect on it, to a degree, so that it is necessary to add the alum to the bichromate of potash and grind both in a mortar to a fine powder, and then while stirring the hot gelatin pour in the bichromate powder slowly. The acetic acid can then be added and the whole filtered again.

The first method I employed for coating the paper required two pairs of hands. One pair of hands to pull the paper through the "guard" and the other pair to lower the

" guard " to just the right depth on the surface of the gelatin. The tin trough to hold the gelatin and the construction of the " guard " are shown in the diagram.

The " guard " is made of well-seasoned hardwood, with a piece of No. 8 brass wire secured to it with two screws at both sides. The wire guides the sheet of paper to the edge of the scraper so that the paper does not go below the surface of the solution and permit any of it to flow on the back of the paper. Of course the " guard " can be lowered so that the solution may flow over the back, but the object of the " guard " is to prevent this, and a little practice will teach just how to do the coating properly.



ONE-MAN DEVICE FOR COATING PAPER.

After a few months' use of the " guard " guided by hand I devised a simpler and better method of coating the paper which was used ever after.

This most effective device was made by fastening the " guard " to two pieces of tongued strips that fitted into and moved up and down in grooved strips. The " guard " thus became part of a square frame. Two springs held the guard

suspended so that the "guard" was above the trough. A foot-pedal, connected with this frame and guard by an iron rod, brought down the frame by pressure of the foot on the pedal so that a single operator could pull the sheet through with his hands while he regulated the contact of the sheet with the solution by the pedal. As the surface of the gelatin coating solution lowers in the trough a thumbscrew regulates the frame so that the proper distance of the "guard" from the solution is maintained. Just over the trough was fixed a bar through which two pin-points projected. On these points the sheet was hung to drain in the trough while the sheet was examined for air-bells and specks of dirt. The diagram shows the device.

DRYING THE COATED SHEETS.

After the sheets are coated they are not pinned up but hung on pin-points in this way: Square wooden rods, 2 inches square and 8 feet long, are punctured through, near one edge, with large "bank" pins so that the points project through, and the corners of the paper are hooked on these pin-points; the points being arranged about twenty inches apart so that they come near the corners of a 22-inch wide sheet of paper. When one of these racks is filled with the five sheets which it will hold, it is removed so that another rack may be filled. Of course these plans are for a large establishment, for the writer was accustomed to coating from thirty to eighty sheets a day. The methods for a smaller plant will be described later.

THE COATING-ROOM.

The darkroom in which the coating and drying of this sensitized transfer paper is done should be heated with steam-pipes so arranged that a temperature of from 80° to 130° F. may be had any day in the year. Further, an outlet valve must be placed on the steam-pipes so that "live" steam may be turned on in the coating-room. A wet and dry bulb thermometer or psychrometer will give the degrees of heat and humidity. While the paper is being coated the dry ther-

mometer should record 80° F. and the wet bulb thermometer ten degrees lower. After the coating is finished heat may be turned on in the room until it reaches 130° F. without injury to the paper. In fact the quicker it dries, within certain limits, the higher the gloss on the paper and the sharper the line that can be developed on it later. The moisture in the room allows the hot gelatin to take hold of the fiber of the paper by penetrating its surface before drying, and also keeps the paper from curling at the bottom when drying.

INSTRUCTIONS FOR COATING PAPER.

The principal points to be observed in the coating of the paper: When pulling the sheet through the "guard" it will be found that the quicker the sheet is drawn through, the heavier the coating raised from the trough on the surface of the paper; while the slower the paper is drawn over the solution, the thinner the coating left on the paper. By taking advantage of these points a perfectly even coating may be had on the paper. If the sheet is started through the "guard" quickly and the speed gradually slackened as the end of the sheet is being coated, then the coating will be even as regards the top and the bottom of the sheet. The reason for this being that with a heavier coating on the top of the sheet and a thinner coating below, the whole equalizes before the gelatin sets. The precise speed for pulling the sheet through can only be learned by practice. Another point to be guarded against is air-bells on the surface of the sheet. These must be watched for and touched with the end of the finger while the solution is still flowing so that the bare spot is covered and will not show when the coating is dry. The third danger to avoid is that the bottom corners of the sheet do not curl so as to stick to the face of the paper. The bottom edge of the paper has a tendency to curl inward, though only for a minute or so, when it straightens out again and will dry almost straight in a hot, humid room. It is needless to add that the coating-room should be lit by a yellow light, as the paper when dry is quite sensitive to actinic light. An electric incandescent bulb will not injure the paper.

Within an hour or less time the paper should be thoroughly dry. After taking it down, the strip at the bottom of each sheet containing a thick rim of gelatin should be sheared off and the paper stored in a pile with a weight on it to keep the sheets flat. A portfolio with covers of heavy wooden boards makes a good holder to keep the sensitized sheets perfectly flat. The printing-room where the sensitized transfer paper is used should of course be lighted only by yellow light. Any quantity of light may be allowed into the printing-room provided the light is entirely yellow.

THE NEGATIVE REQUIRED FOR PLANOGRAPHIC PRINTING.

One great advantage the photoplanographic transfer method has over the photorelief plate methods is that the negative required for the former does not require the intensity necessary for the latter. Therefore the greater gradations in the lines and dots can be had by the transfer method. Every experienced photographer understands the great loss in gradations in a negative when intensification has to be forced. And the destructive action of the "cutting" solution when clearing the deposit from filled-in fine lines is known to every one who thoroughly understands making a process negative. So that the transfer method has in its favor the possibility of starting with a perfect negative, and a perfect negative should precede the manipulations of all photo processes, though unfortunately that is not always so.

THE COLLODION.

The simplest way to keep a formula for collodion in mind is to know the number of grains of each ingredient used to each ounce of the solution, which is ether and alcohol combined. It is important that the chemicals used should be pure. The alcohol should be ninety-five per cent grain alcohol. If it contains much more water than five per cent it will not dissolve the guncotton perfectly. The ether should be that known as sulphuric ether, though much of the collodion base sold is made with methylated ether. The pyroxylin, commonly known as guncotton, is most important. There

are some brands to be found that are excellent, though guncotton is exceedingly variable in its character. It pays to buy a good make of guncotton, and if it works well continue using that brand. The iodid of ammonium can be purchased with crystals either white or brown in color. The writer, using large quantities of collodion, prefers the brown because collodion made with it "ripens" quickly and gives greater intensity in the negative, though it does not keep in condition for use so long as collodion made with the white crystals. The bromid of cadmium is the preservative in the collodion. Remember always that iodids in a collodion give hardness or contrast — just what is required in line negative-making — and the bromids produce softness.

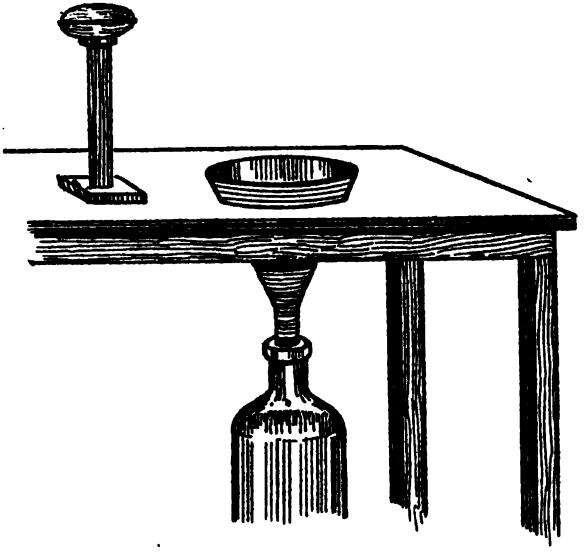
FORMULA FOR LINE COLLODION.

Here is the simplest formula for collodion ever published. It is the result of years of practical experiment, and, when tried, will be found to give superior results, with the further advantage that it does not contaminate the silver bath as quickly as the complicated formulas for collodion that are in common use. This collodion is ready for use almost immediately after compounding.

Alcohol and ether.....Equal parts
Guncotton..7 grains to the ounce of combined alcohol and ether
Iodid of ammonium.....5 grains to the ounce of above
Bromid of cadmium.....1 grain to the ounce of above

The amount of guncotton can be varied to suit the character of the cotton, and the size of the glass to be flowed with the collodion. It will be understood that small-sized pieces of glass can be covered with collodion quickly and consequently a thicker solution can be used, while with large sheets of glass the coating of the surface with collodion takes so much longer that the greater evaporation of the ether and alcohol produces a thicker film from a thin solution than when small sheets of glass are coated. Where the average-sized sheets of glass to be coated are 14 by 17 inches, then five grains of guncotton to the ounce might be sufficient.

The writer used when coating the larger sizes of glass up to 22 by 26 inches a glass plate rest, as shown, and always drained the collodion into a funnel set into a table. In the bottom of the funnel was a pledget of cotton through which the collodion was filtered into a bottle under the table.



FOR COLLODIONIZING LARGE GLASS PLATES

The glass used for negative-making should of course be perfectly clean and be coated on one side with a substratum of albumen to keep the collodion film secure to the glass support during all the washing operations.

TO CLEAN GLASS.

Nitric acid and water will answer for cleaning glass. A solution of 1 part nitric acid in 10 parts of water, kept in a stoneware tank, makes a good glass-cleaning solution. The glass should be left in this cleansing bath over night. It would be better to stand the sheets of glass on their edges if the bath is deep enough. If the glass plates must be laid flat on each other it would be well to have some short pieces

of straw to go between the sheets to keep them separated so that the acid solution may attack the whole surface of the glass. Straw is not readily acted upon by nitric acid, and it does not injure the surface of the glass.

In the morning the glass should be removed, without scratching, from the acid bath. When it is drained each sheet should be laid on a broad clean board and scrubbed with a bristle brush on both sides and particularly on the edges. These edges are too often neglected, and the dirt from them is one of the causes of contamination of the silver bath. When the dirt is scrubbed completely from the glass it is washed on both sides under the running water from a tap, drained, and flowed with the following substratum.

ALBUMEN SUBSTRATUM FOR GLASS.

The albumen from one fresh egg, which should weigh about an ounce, is beaten up thoroughly and mixed with forty ounces of clean water, after which a dram of water ammonia, stronger, U. S. P. twenty-six per cent, is added. This solution is filtered carefully and flowed on one side of the glass only, then the glass is stood up on its edge in a rack to dry in a place free from dust. The proper cleaning and albumenizing of the glass assures success in the subsequent operations of negative-making so far as preventing dirt from appearing under the film on development or permitting the collodion to tear and strip from the glass during the washing operations. This work should not be left to a careless boy, without being supervised occasionally to see that it is properly done.

THE SILVER BATH.

The preparation of the silver bath is the simplest of operations, though it is the solution that gives the most trouble owing to the principles governing its proper working not being understood.

Distilled water containing forty to forty-five grains of nitrate of silver to each ounce of water, made slightly acid with a few drops of chemically pure nitric acid and contain-

ing a trace of iodin, is all that constitutes a perfect silver bath.

The trouble comes from the fact that the proportions of the ingredients begin to change from the sensitizing of the first plate in the silver bath, and besides, foreign matter is absorbed by it.

Sufficient silver-bath solution should always be on hand to fill twice the holder or dish in which the silver bath is used. When the quantity of distilled water required is measured, then forty grains of nitrate of silver is dissolved in the water and the solution tested for acidity with litmus paper. Nitric acid, chemically pure, is added drop by drop and stirred in until the solution just turns acid. A glass plate is coated with collodion and lowered on a holder into the silver bath. This collodionized plate is left in the bath for say fifteen minutes, when the solution will have absorbed enough iodin from the collodion to put the bath in proper condition.

Should the first plate sensitized in the new silver bath show a slight fog over the whole plate — a fog that can be removed by the finger from the surface — then the silver bath requires a few more drops of nitric acid. If the first negative is thin in appearance, then the amount of iodid in the bath is still insufficient. This last will remedy itself after a few plates are sensitized in it.

About all that is necessary to be borne in mind regarding the silver bath is: Each plate sensitized in it removes some of the nitrate of silver and adds a little alcohol, ether, iodid of ammonium and particles of dirt. The dirt can be filtered out, if the bath is not so acid that it dissolves the dirt. The alcohol and ether can be evaporated out. The iodids can be removed by pouring the silver bath into a quantity of distilled water, when the iodid will be changed from solution into fine particles in suspension, shown by the bath turning a creamy white. These iodid particles can then be filtered out and the bath strengthened up to the normal forty grains to the ounce; or, the bath can be placed in a porcelain evaporating-dish and the excess of water, together with the alcohol and ether, evaporated until the bath is reduced to its original

bulk. During warm weather the exposure to the sun for days of the bath solution not in use, in a white glass bottle, is often sufficient to evaporate the alcohol and ether in it and throw down to the bottom the dirt and other foreign matter from the solution.

THE CAMERA AND LENS.

The offset press can print maps so much larger than the typographic press that it would seem as if the cameras used for offset-press work would have to be so much larger, which is not the case. The photoplanographic process here described permits the making of the largest maps in several sectional negatives which may afterward be printed on transfer paper, and the transfers joined together perfectly so that the necessity of large negatives is obviated.

A camera to make a negative 14 by 17 inches and smaller is the size of camera most serviceable. It should be strongly built and used on a camera stand of the most rigid pattern. The bed of the camera-stand, or the whole camera-stand, should be supported on springs of some kind to absorb the vibration, for vibration is the greatest enemy of sharp negatives. Do not rest the camera on the floor and fasten copy to the wall in the expectation of getting perfectly sharp negatives.

For a lens choose one of the anastigmats of modern construction, and have its focal length about that of the diagonal of the largest plate to be made with it. For instance, the size of the actual work on a 14 by 17 negative, allowing one-half inch margin all around for working, is 13 by 16 inches. The diagonal of this is 20½ inches, therefore a lens of twenty inches focal length would be ample. It will be found that with some of the modern lenses a sixteen-inch focus lens will cover sharply a 14 by 17 plate by using a small diaphragm, which lengthens the time of exposure. Where much small work is done on say 8 by 10 inch glass, then an additional lens of about ten inches focus is a great saver of time and money.

An exceedingly fine-grained ground glass is essential for

sharp focusing together with a strong magnifying focusing glass.

REVERSED NEGATIVES.

The offset press requires reversed transfers so that negatives for it should be reversed as regards right and left. This can be done through the use of a prism or mirror in connection with the lens, or by stripping the negative film from its glass support and turning it over as is done in photoengraving. There is the third method of reversing, which consists in turning the glass, instead of the film side, toward the lens, thus photographing through the glass. All three methods are in use.

Reversal through the prism is the most reliable way, though it increases the time for exposing the negative at least twice and frequently three times. The camera must be arranged at right angles with the copy-board when a prism is used. Mirrors can be had as substitutes for the prism. These are made either of optically flat glass silvered on its surface or of polished speculum metal. Mirrors are less costly than prisms to begin with, but after use they are liable to be scratched in the frequent polishing necessary when they do not reflect the image sharply, so a prism is the cheaper investment.

Stripping the negative film and turning it over on the glass support is adequately described in the chapter on photoengraving. A drawback to this method of reversal is the danger of distortion in the design when several films are to be joined to make up a large design, or lack of register when making separate color-plates in a color-plate set. When slight distortion does not matter, reversal by turning the negative is a quite practical method.

Reversal by turning the glass side of the sensitized plate toward the lens instead of the film side, as is customary, is an effective method providing good-quality glass is used and the back of the glass, which is to face the lens, is polished perfectly clean before inserting in the plateholder. When developing a plate exposed this way it must be remembered that the image will appear on the under side of the film.

The uprights supporting the copy-board should be absolutely rigid so as to prevent the slightest possibility of vibration. The copy-board itself must be at right angles in every direction with the axis of the lens. That is, it must be parallel with the ground glass and sensitive plate, and when a prism or mirror is used the copy-board must be at absolute right angles with the sensitive plate. This is in order that there shall be no distortion in the dimensions of the image on the ground glass.

The copy-board itself should slide in grooves laterally so that it may be taken out if necessary and laid down on a table when intricate copy is to be attached to it. Another reason for the lateral movement is that when a prism or mirror is used, the copy-board will have to be pushed to one side of its normal center.

Copy-boards crossed with grooves or bored with holes in which clips are used to hold down the copy are most excellent ideas. Another plan, to secure copy flat without puncturing it with holes from tacks or pins, is a glass frame, on the photographic printing-frame principle, and called a "copy-holder," in which the copy is first framed and then the frame itself secured to the copy-board. A large sheet of plate glass can be used to hold copy flat and the plate glass held by clamps to the copy-board, though by this plan there is danger of reflection of light from the camera and its surroundings into the lens.

Reflected light in the lens other than that from the copy will give the photographer constant trouble if he does not watch out for it.

All copy-boards should be painted a dull black. The reason for it is this: All extra light reaching the sensitive plate other than that coming from the copy uses up both silver and developer that should go to building up the intense image on the photographic plate. It would seem but a small matter, still it is the cause of thousands of dollars waste each year, and this is the first time that attention has been called to it.

For even illumination of large-sized copy there is nothing

to compare with daylight. As this light must come through glass, there should be ample skylight and side lights when possible. The writer always used a plate-glass mirror as wide as the copy-board to rest on the camera bed and reflect the light from above toward the copy. This mirror will be found indispensable, once used. It is well to have the front of the camera cone-shaped, that is that the front holding the lens should be as small as possible, so that it does not cut off too much light when enlarging copy. The drawback to daylight is that it changes as the day progresses, or when the sky is overcast with clouds so that proper calculation of exposures to meet changing conditions is difficult.

On the *Daily Graphic* the writer had the immense skylight room on the roof connected with the darkrooms below with an elevator. The operators in the "lightroom," as it was called, looked after the focusing of copy and the exposure of the sensitive plates so that they became expert in noting changes in the light and making calculations therefor. The men in the darkroom below never did anything but the development and intensifying of the negatives. This division of the work is much better in large establishments than where each operator has to work in both lightroom and darkroom alternately. The constant changing from lightroom to darkroom is injurious to the eyes, and while he is working in the darkroom the camera is idle and while using the camera the darkroom is unoccupied.

ELECTRIC LIGHTING.

There is economy in the electric lighting of copy on account of the uniformity of the illumination, though it can not compare with daylight in the evenness of illumination. Through the use of electric lights the calculation of exposure should be the same, morning, noon or night, winter or summer, so that the output of negatives can be calculated upon to a certainty, and this is the only way to make the business profitable.

Improvements are coming so frequently in electric lighting that what could be stated here as to the best type of

electric lamp to use might become in a few months out of date. In the early days we had the open-arc type of lamp, supplied from our own dynamo as the street service current was unreliable; then, after various changes in the types of lamps, we thought the question was solved with the Cooper-Hewitt light. Then came the enclosed arc lamp as an improvement, and now the flaming arc type of lamp is preferred.

For economy of current and the photographing of black and white copy the enclosed type of arc lamp is still used; while for copy in colors or where speed is necessary in turning out work, the flaming arc type of lamps, notwithstanding their increased consumption of current, are after all the more economical. The most perfect method of artificially illuminating copy has not yet been devised. In the crowded conditions that usually prevail around copying cameras it is better to have the electric arc lamps suspended from overhead trolleys so they can be moved near or far from the copy-board, and the lamps should be counterbalanced by weights or other device so that they can be raised and lowered with ease.

MAKING THE NEGATIVE.

These instructions refer particularly to the application of photography to reproduction for planographic printing either from stone or metal plates on the lithographic press or from the offset press. In this work large-sized pieces of copy must be considered, and large negatives must be handled. So we will begin by fastening the copy to the copy-board before sensitizing the plate, for the reason that if there is any contraction or expansion to take place in the copy due to atmospheric changes these movements will occur before the exposure.

CARE OF THE COPY.

No matter what the method or combination of methods used in attaching the copy to the board, the habit should be acquired at the beginning of treating each piece of copy as if it was as precious as the original Declaration of Indepen-

dence. Clean hands and clean tables — everything clean which the copy may touch. But above all things do not use carpet-tacks or nails to punch holes in the copy when fastening it to the board. Use glass push-pins with steel points and large bank-pins, if tacks of some kind must be used, as these do not puncture large holes in copy and are most effective in holding to the soft pine wood of the copy-board. The bank-pins are ordinary pins about three inches in length. Whenever possible, a large sheet of polished plate glass should be utilized to press copy flat to the board, taking care that reflections, even that of the lens in the plate glass, are watched out for and provided against.

FOCUSING.

The ground glass on which the focusing is done is supposed to be of the very finest grain, still it is well to paint two streaks of glycerin or oil across the ground glass from corner to corner so that even finer focusing may be done. Parallelism between the ground glass and copy-board is absolutely essential, particularly when several negatives must be made from different sections of large copy, to be joined together later. Measurement on the ground glass of a large square on the copy-board is one way of determining this perfect parallelism, though other methods will suggest themselves to the intelligent operator. With most lenses it is best to focus sharp with a large diaphragm midway between the center and the corner of the copy, and then trust to the smaller diaphragm, used when exposing the plate to bring all of the copy sharp on the plate. It is while focusing that reflections of stray light should be looked out for. When illuminating large drawings, particularly on tracing-cloth, where the India ink is glossy, there is a danger of reflected light from the glossy ink at the edges of the drawing.

These instructions are intended for the photographer who has had experience in the manipulations of the wet plate, so that the details regarding collodionizing, etc., will

not be gone into except where they relate to handling the large work required by the planographic press.

COLLODIONIZING, SENSITIZING AND EXPOSING THE PLATE.

The plate rest recommended when collodionizing large plates shown in the paragraph on collodion will be found essential. The regular collodion bottles with glass covers prevent dust and the evaporation of the solvents and are indispensable. For sensitizing the plates an upright dipping bath for plates up to twenty inches is most convenient, but when plates are larger one way than twenty inches a tilting flat dish is preferable.

Care in dipping plates into the upright bath or flowing them with the silver solution when a tray is used to prevent streaks is well known. After the plate is sensitized it should be slowly raised from the silver bath and hung on the dipper over the bath so as to drain as much of the silver solution as possible back into the bathholder. When thoroughly drained the glass plate is allowed to rest on strips of clean blotter, while the top edge of the plate and the back are wiped dry of silver solution.

If the exposure is to be prolonged and there is danger of the plate drying, a sheet of black or red blotter wet with water is laid on the back of the plate. With the method of exposure the operator is supposed to be familiar. As to the time of exposure, that is a matter impossible to advise on, as it varies with every factor that goes into the making of the negative.

DEVELOPMENT.

It is in the development of large negatives that the skill of the operator is most evident. But we will first consider the composition of the developer. It is well to fix in the mind that the amount of iron sulphate, U. S. P., need not be greater than eighteen grains to the ounce of water. In the early developers we used it was as high as thirty grains to the ounce of water. Iron is the developing agent, acetic acid being added to restrain the action of the iron and prevent

fogging, while alcohol is added merely to make the developer flow readily when the silver bath contains an excess of alcohol. These are the principles that govern this most important operation and now are the approved practice.

Iron sulphate, U. S. P., in pure crystals should be put, on receipt, into a stoneware crock and covered with clean or distilled water until a saturated solution of iron is formed. For use take some of this saturated solution and dilute it with clean water until it tests twenty degrees with a regular water hydrometer. (Such as is used for testing silver baths.) To every twenty-four ounces of this iron solution add one ounce of thirty per cent pure acetic acid or one-half ounce of glacial acetic acid. Enough grain alcohol — not wood alcohol — may be then added to make the developer flow readily. With a new bath no alcohol should be required.

THE ADDITION OF GELATIN TO DEVELOPER.

The writer has experimented with the addition of sugar, molasses and other colloidal substances to the developer and finally settled on the following as being the best restrainer for developing large plates.

An ounce of gelatin is allowed to soak up as much cold water as it will, in a stoneware jar, then three ounces of sulphuric acid is added to it very slowly while the gelatin is being stirred with a glass rod. The solution becomes very hot. When it is cool, six and one-half ounces of aqua ammonia is slowly stirred into the acidified gelatin. This amount of ammonia should turn the solution neutral. Add six ounces of glacial acetic acid, and make up the whole to eighty ounces of stock solution. Use one ounce of this, in place of acetic acid, to every twenty ounces of developer, and you will remark the ease with which large plates may be developed and the great intensity secured without fogging.

The reason for it is this: The thicker a liquid is, the slower a small particle can get through it. When a solution of sulphate of iron (developer) is flowed upon a glass plate, holding iodid and nitrate of silver which has been acted upon by light, each particle of iron rushes to combine with a par-

ticle of silver. Without the gelatin or other substance to thicken the liquid and retard its progress these particles of iron attach themselves to the particles of silver in an irregular manner, and when such an image is examined under a microscope it will be found that the deposit of silver and iron in the film looks like coarse black sand. Some of the sand particles are in the portions of the film that should be absolutely transparent. This, to the eye, is what is termed " fog." With the gelatin in the developer to obstruct the particles of iron the developed film when seen under the microscope is much finer in the grain, the deposit taking place only where the light has acted upon the film, and the edges of the lines are smooth and sharp in comparison with the ragged-edge line shown when the developer is used without gelatin.

GET IT IN THE NEGATIVE.

This is one of the refinements in photographic work that makes superior negatives, though known to few operators. Where large negatives are wanted this gelatinous addition to the developer permits an evenness of development quite impossible without its use, when handling large work for lithographic or offset-press printing. The basis of all photo-process work is the negative, and that should always be the best possible, for no amount of work afterward will make up for deficiencies in the negative. It was recognition of this fact that brought the writer so many compliments for his brief article in Penrose's Pictorial Annual for 1909-10, entitled " Get It in the Negative."

DEVELOPING THE IMAGE.

A perfect negative being the basis of all good process-work, and as the quality of the negative is determined only after development, it can be seen how important it is that this operation be performed intelligently. The first thing to be learned is to flow over the exposed collodion plate, in one uninterrupted sweep, only just enough developer to cover the plate without allowing any of the developer to spill over the edges of the plate. This might seem easy to do, and when

the beginner tries it a few times and fails he thinks it is impossible of performance; still the men who are making the best negatives do not allow much if any of the developer to leave the plate during development. In fact the experience and skill of the wet-plate photographer can be told by the success in which he holds the developer on the plate.

The reason for this care in flowing the developer over the plate is that besides the iodid and bromid of silver, which comprise the sensitive substances on which the image is impressed by light action, there is an amount of what is termed "free silver" on the surface of the film which is necessary for the proper development and intensity of the image when the iron solution is flowed on. If, with the first sweep of the developing solution over the plate, this free silver is washed off, then the image developed will be so much the weaker in density.

FREE SILVER NECESSARY IN DEVELOPMENT.

To prove the necessity of this free silver in the development of the image it is only necessary to sensitize a collodion plate as usual, then wash off the free silver under the tap before exposing the plate in the camera, and afterward try the development of it. Then sensitize, and wash off the free silver from a second plate. Expose it to light, but before development dip it in the silver bath again, and then see the difference. The latter will appear to have the greater sensitiveness, as it will develop into the better negative.

The developer works best at a temperature of 60° F., and does not work well when it is so old that it appears brown in color.

After proper development the negative requires sufficient washing under the tap. It might be advised here, in all washing of negatives under the tap, to get the habit of permitting the full force of the water to strike a corner of the plate and flow over the image, and not let it flow directly on the image. Many a negative is injured by particles of solid matter, in the flowing water, striking the plate and puncturing the film where the damage was irreparable.

Cyanid of potassium, in the proportion of one ounce to twenty-four ounces of water, is the proper solution for fixing the negative. It should be used in a glass bathholder similar to the one used as a container of the silver-bath solution. Should it be necessary to use the cyanid solution in a tray, it must be provided with a cover. The common practice of using cyanid of any strength, out of a bottle, and pouring it on the negative is all wrong. The fumes of cyanid are injurious to health, and as cyanid above a certain strength will not only dissolve away the unacted upon salts of silver in the plate but attack the silver of which the image is composed, it will be understood that when overstrong cyanid is poured on the negative it destroys some of the image where the flow is greatest. By using a bathholder and allowing some seconds for the cyanid solution to clear the negative, all this danger is avoided. It may be unnecessary to warn users of cyanid as to its poisonous properties, but it is not so well known that any acid reaching cyanid of potassium evolves hydrocyanic acid, which is the dangerous gas commonly known as prussic acid gas. By way of warning, it might be added that three grains of cyanid of potassium taken internally is fatal.

INTENSIFICATION.

A good rinsing of the negative from all traces of the cyanid of potassium should precede intensification. As we are considering only the methods of producing a perfect negative for planographic printing we will use an ideal intensifier made up as follows: First make up the following three solutions:

1. Bichlorid of mercury.....120 grains
   Water ..... 12 ounces
2. Iodid of potassium.....180 grains
   Water ..... 4 ounces
3. Hyposulphit of soda.....240 grains
   Water ..... 4 ounces

Pour the second solution into the first, making a beautiful red emulsion, iodid of mercury. While stirring this emul-

sion add the third solution, when the red color will disappear. Pour this transparent solution over the negative and it will, when it is continued sufficiently and penetrates the film, give a beautiful density without harshness or danger of filling up the fine transparent lines.

One point must be advised strongly here, and that is not to do any "cutting," as is customary in half-tone negative-making, on a line negative. It may be said to make the final printed result "muddy" as a reproduction. When an operator does any "cutting" on a line negative he shows that he is unfamiliar with the principles that go to perfect line reproduction by any process.

INTENSIFICATION WITH MERCURY.

Another suitable intensifier for the negative that does its work without producing harshness is bichlorid of mercury. The strength of the solution used does not much matter. It can be a saturated solution, when it works quickest, while the more dilute it is the slower it bleaches the film white. It should be acidified with a few drops of hydrochloric acid before use. Here is a definite formula for it commonly used:

Bichlorid of mercury	1 ounce
Chlorid of ammonium	1 ounce
Water	20 ounces
Hydrochloric acid	1 dram

This mercury intensifier had better be used in a tray kept for that purpose exclusively. The solution can be rocked back and forth over the negative until it is found by looking at the back of the negatives that the film is bleached white entirely. Then wash the negative well to remove all trace of bichlorid of mercury from the film other than that taken up by the image, otherwise a yellow stain will be produced when the film is treated with the chemicals that blacken the image. The slightest yellow stain in the transparent parts of the negative adds considerable time to the exposure required in the printing-frame.

We have a number of agents that will blacken the image after it is bleached with bichlorid of mercury. Sulphid of

sodium is most generally used at the present time. Ammonia at the strength of about one ounce to ten of water was formerly used, or one ounce of sulphit of soda to ten ounces of water. After the image is blackened it should be flowed over with a solution of say a quarter ounce hydrochloric or nitric acid in ten ounces of water. This removes at once any tendency to stain. Should the intensification be insufficient the operations may be repeated, though the washing between operations must be thorough.

IODIN INTENSIFICATION.

One of the most delicate intensifiers is iodin used in this way: In ten ounces of water dissolve three-quarters of an ounce of iodid of potassium and then dissolve in it a quarter ounce of iodin crystals. Flowing this over the negative, after it is fixed and well washed, changes the image to a beautiful cream-yellow color. When the iodin has penetrated through the film the negative is well washed and flowed with one ounce of sulphid of ammonium in four ounces of water and washed again.

The regular photoengraver reading the list of these intensifiers will notice that the copper and silver intensifier he is best acquainted with from constant use has been omitted. The omission is intentional. Copper and silver is useful in its proper place as an intensifier, but the intensifiers given are better for the work now under consideration where great intensity in a negative is not so essential as that the smoothness of the edges of the lines be preserved as well as the relative gradations in the widths of lines or dots as found in the copy, and this copper and silver does not preserve, while "cutting" the negative destroys the relative gradations.

"PHOTOGRAPHING BY STEAM."

When J. Trail Taylor, late editor of the *British Journal of Photography,* visited this country, it was the writer's privilege to show him through the various rooms in which the "Graphic" process was performed. The article which he wrote describing what he saw was entitled "Photograph-

ing by Steam." The reason for this was that he found we plunged the negative into tanks of almost boiling water after developing, fixing and intensification to quickly wash them free from chemicals not wanted.

These tanks were wooden boxes, lead-lined, in which there was a steam-pipe open at the end so that "live" steam could be turned on and boil the water, if necessary, in the tank. By holding a large-sized negative by one of its corners and plunging it quickly into the almost boiling water, the heat striking the glass equally on both sides prevented unequal expansion and any danger of cracking the glass. The hot water removed the superfluous chemicals almost immediately, so that the speed with which we turned out large negatives in those days by this application of steam to photography would make some of the modern "records" appear ridiculous.

PROTECTING THE NEGATIVE FILM.

The most valuable application of steam was in the final rinsing. In the steam-heated drier was a glazed teapot of hot gum-arabic solution, and the hot-water tank for the final rinse was close to the drier, so that the instant the negative was drawn out of the hot water it was flowed with the solution of hot gum and the door of the drier closed on it quickly so that it was dry in a few seconds. This method of drying negatives and protecting the film from scratching can not well be improved upon.

RETOUCHING THE NEGATIVE.

Every negative should be inspected in a retouching-frame before being printed from. All holes in the film or transparent spots not wanted should be stopped out with an opaque pigment like India ink thickened with gum arabic. This dispenses with the troublesome scraping, to remove these blemishes, when they reach the planographic transferrer.

More important than stopping out these spots is the examination of the transparent lines to see that they are not acci-

dentally broken anywhere. These broken or filled-in lines occur most frequently from weak lines in the drawing not seen by the artist. When these lines are mechanical and perfectly straight they can be etched in on the negative with a needle point moved along the side of a metal straight-edge. Or when they are curved various shapes of artists' drawing, curves in celluloid may be used to guide the needle. Celluloid triangles also will be found indispensable for this work. Should the weak lines be made by free-hand drawing, such as are found in maps, cartoons or pen-and-ink sketches, these delicate lines can also be cleaned up in the negative, though the work should be done by one with artistic training. When the filled-in lines in the negative come from gray lines in a piece of wood-engraved or intaglio-engraved copy, it is difficult to imitate them with a needle-point in the negative. No negative should be printed from which has any blemishes that can be removed.

PHOTOLITHOGRAPHY.

From the negative we will first consider the production of a photolithographic transfer, as this is the most convenient method of getting designs on the offset press or on stone or metal when printed from in the planographic manner. When large maps are to be joined together, or when illustrations are to be inserted in a border, or lines of type to be added to maps or illustrative matter, there is no easier method of doing all of this than by using transfers. All of which is known to the lithographer, but not to those handling the offset press, who are not trained lithographers.

The method of making the ideal photolithographic transfer paper has been fully described, and this is the way to make use of it: It is printed upon from the negative in an ordinary photographic printing-frame just as a piece of regular printing-out paper. That is, in a room lit by yellow light, a piece of the sensitized photolithographic paper, large enough to cover the negative, is placed in the printing-frame behind the negative, and the whole exposed to sunlight for about thirty or forty seconds, or until the image shows a

bright brown against the yellow ground of the paper. The fact that the print can be examined and the correct exposure determined by the color of the exposed image prevents any uncertainty in timing the length of the exposure to light.

INKING THE PHOTOLITHOGRAPHIC PAPER.

The best way to cover the photolithographic prints with an even film of transfer ink is to lay them face down on a lithographic stone or polished zinc plate that has been rolled up with an even film of such ink. The prints should be dampened before coating with ink, and instead of laying them between damp blotters in a dampening book it is recommended that they be placed in a dampening closet arranged like this:

A cabinet containing shallow drawers about an inch deep has galvanized wire open-mesh screen substituted for the bottoms of the drawers. Into the top and bottom drawers, as well as every alternate drawer, are laid wet blotters, the photolithographic prints to be dampened being laid on the wire screens in the bottom of the alternate drawers that are without blotters. In this way the photolithographic prints absorb moisture from the wet blotters without coming into contact with them. When the prints in the drawers are limp they are sufficiently damp to be laid face down on the inked stone or metal plate and run through the press.

THE TRANSFER INK.

The transfer ink can be the one that the transferrer approves of, for there is a wide range in the choice. The writer has been successful with an ink composed of five parts of German transfer ink, softened with No. o varnish and mixed with four parts of crayon ink, softened with oil of lavender. Other transferrers prefer equal parts of transfer ink and lithographic printing-ink ground in No. o varnish, while what is known as stone-to-stone transfer ink answers very well. One thing that can be stated with certainty is that there is no excuse for any one making his own ink, as recommended in the books, for much better ink than they

can possibly make is to be had at any lithographic supply house.

It should be said that the film of ink on the paper can preferably be so thin that the yellow tone of the paper shows through the ink. When the prints are laid on the inked stone or metal and pulled through the press they are pulled from the stone and laid down in their places reversed, so as to insure a more even coating and also that every spot of the print may be covered with ink.

DEVELOPING PHOTOLITHOGRAPHIC TRANSFERS.

The inked prints are now floated for a few minutes on the surface of water that is nearly boiling, when the ink takes on a beautiful gloss. Some practice is required in floating the prints, as they curl up if not prevented from doing so, and the hot water getting over the face is liable to spoil the transfer. Floating on water almost to the boiling point softens the ink and draws it into absolute contact with the light-hardened image on the paper at the same time the water penetrates through the unhardened gelatin coating and repels the ink from its surface. This can be determined when the inked print begins to lose its original gloss. The print is then removed to the wet surface of a sheet of plate glass, laid on it, and with a wet soft Turkish sponge the ink is washed away from the gelatin surface where the light has not acted upon it, leaving an image in sharp lines of transfer ink. The print is plunged into clean water and left until all of the soluble bichromate of potash is dissolved out of it, when it is hung up to dry. While drying, all water spots that rest on the image must be removed with the edge of pieces of blotter because they contain a slight trace of gelatin which, drying on the lines, would prevent them transferring. When the transfers are dry they are ready to be transferred to lithographic stone, aluminum, or zinc plates, either for direct printing from zinc or from zinc on the offset press after reversal.

COLLOTYPE.

METHOD OF

PRINTING FROM GELATIN IN THE LITHOGRAPHIC MANNER.

Collotype is one of the earliest of the photomechanical printing processes. In Germany, where it is worked most successfully, it is called lichtdruck, in France, phototypie, and in the United States it is known as albertype, artotype, heliotype, autogravure and plain gelatin printing. Its proper title is collotype, and it has come down to us from Louis Alphonse Poitevin, a French chemist and engineer, who received a prize for the process in 1855. It was improved upon since that time by Tessier du Mothay, Lemercier, Albert, Obernetter, Husnik, Sprague, Sawyer, Colonel Waterhouse, Ernest Edwards, T. C. Roche, and others. So the method has proved worthy of the attention of the brightest experimenters in photomechanical printing.

The results possible of attainment by collotype are deserving of study by processworkers and particularly those with a knowledge of lithography.

THE PRINCIPLE OF COLLOTYPE.

Collotype is a process by which a film of gelatin is made selective of either greasy ink or water so that it may be printed from in a lithographic manner. The gelatin is sensitized with a bichromate and given a grain on drying. This sensitized gelatin is exposed under an ordinary photographic negative, washed and dried, and then treated somewhat similar to a lithographic stone, to which it shows corresponding properties. It is a simple process, which has been successfully carried out by amateurs at photography, though it is so sensitive to fluctuations of temperature and humidity that it has been worked more easily in countries having a more equable climate than that of some portions of the United States, and still with our present methods of

producing artificial climates in a factory there is nothing now to prevent this process being worked anywhere.

THE SUBSTRATUM.

The first difficulty the early workers had with the process was that the gelatin film would strip from its support, which was usually glass. This was overcome by giving the glass a fine grain and coating this glass with a mixture of bichromate and gelatin which was exposed to light through the glass support. By this means an insoluble film was had on the glass, which held the subsequent coating secure. Later it was found that silicate of soda (water glass) and an organic substance made a suitable substratum, while the graining of the glass was essential. T. C. Roche, of New York, used copper instead of glass as a support, and Ernest Edwards, of Boston, stripped the collotype film so that it could be attached to zinc or any support. The highest grade collotypes are printed from plate glass about one-half inch thick which has been ground with fine emery powder, care being taken that no scratches occur or they will appear in the print. After washing and drying, the ground plate glass is put on leveling screws in a drying closet free from dust and flowed with the following substratum:

Distilled water	10 ounces
Whites of fresh eggs	5 ounces
Silicate of soda	2 ounces

The eggs must be beaten to a froth and allowed to settle, and the whole mixture shaken thoroughly before being filtered; remembering always that the enemies of perfect collotype plates are bubbles and dust, so that every precaution must be taken against them. In filtering, which must be carefully done, the mixture is carried from the bottom of the funnel to the sides of the vessel to prevent bubbles.

COATING WITH SUBSTRATUM AND GELATIN.

A small quantity of the substratum is poured on the leveled glass plate and pushed over the whole surface with

a glass rod, taking care not to form air bubbles. The plate can then be stood up in an ordinary plate rack to dry.

The actual sensitive coating may be prepared as follows, though each collotyper has his own pet formula.

There are so many kinds of gelatin to choose from — Nelson's, Heinrich's, Creuz's, Russian, Swiss, French — that it is impossible to advise. What is wanted is a middling hard gelatin, though this can be regulated somewhat by the amount of chrome alum added to the gelatin. A simple formula is as follows:

"Middle hard" gelatin	2 ounces
Water	20 ounces
Bichromate of potash	½ ounce
Ammonia, 26° U. S. P.	¼ ounce

Use water that has been boiled to minimize the risk of bubbles, melt the gelatin in the water by heat, stir in the bichromate and the ammonia and pour in one-fourth ounce of a ten per cent solution of chrome alum. The quantity of chrome alum will vary with the character of the gelatin. The gelatin must be stirred briskly while the hardening solution of chrome alum is being added. The gelatin solution must be kept at a temperature not above 100° F. When filtering, either a double funnel must be used, the outer one containing hot water, or a tin pail can be taken and a hole made in the center of the bottom through which the spout of a tin funnel projects and is soldered there. By keeping hot water in the pail the gelatin mixture can be filtered through clean muslin to a pitcher below which is standing in a vessel of warm water.

DRYING THE GELATIN-COATED PLATES.

A suitable drying closet or room is prepared for the drying of the plates. Its construction will depend on the number and size of the plates to be used and the arrangement of the workrooms. What is required is a place illuminated by a yellow light, free from dust, and where a temperature of from 110° to 120° F. can be maintained. It also must have rests for the pieces of plate glass that

will bring the latter absolutely level when tested in all directions with a spirit level.

The pieces of plate glass are placed on the leveled stands, and after careful dusting are flowed with some of the warm gelatin mixture in the proportion of one ounce to 120 square inches of plate-glass surface. The solution is spread with a glass rod, avoiding air bubbles, and is then allowed to dry. The temperature at which the film dries affects the grain. Dried at 110° F. the grain is too fine; dried at 140° F. the grain is too coarse, so that about 120° F. will produce the most satisfactory grain.

Besides being preserved from dust and white light while drying, vibration will cause wavy markings and drafts will give it an uneven grain.

THE NEGATIVE AND PRINTING.

A reversed negative on crystal plate glass must be used, and this can be had by the use of a prism or by stripping and turning as explained elsewhere in this book. The negative should be one with perfect gradations. The dimensions of the print must be indicated by strips of tin-foil secured to the negative. The crystal plate glass negative with its mask of tin-foil is laid in the special deep printing-frame used for collotype, and the sensitized plate glass laid upon it and good pressure applied; black velvet and pure gum rubber, or felt blanket, being used as a backing in the printing-frame.

The exposure can best be timed through the use of an actinometer, of which there are numerous patterns in the market. After printing the gelatin-coated plate glass it is allowed to soak in cold water for an hour or more, or until the bichromate is dissolved out. The yellow color is fixed by the action of light in the shadows, but will wash out of the high lights readily. Now dry the plate and it is ready for printing in ink.

ETCHING AND PRINTING.

For practical commercial work a trained lithographer should undertake the printing. He is provided with litho-

graphic presses, the lithographic and composition rollers, and the stiff and thin inks necessary. Space does not permit any directions for printing, only to give what is called an "etching" solution which lithographers are not usually acquainted with.

Equal parts of water and glycerin to which from one and one-half to two per cent of table salt is added makes a good "etching" solution. The object of this "etching" solution is to make the gelatin film hygroscopic so that it will retain moisture where the light has not hardened the gelatin, and a number of impressions may be pulled without redamping. The plate is allowed to soak in this "etching" solution for a few minutes or an hour or two, depending on the weather, the character of the image, and whether it is to be used on the hand press or the steam press. The plate can be leveled, as before, and the "etching" solution poured on it, and this is the usual practice.

Presses for collotype printing have clamps for holding the glass plate secure to the bed. Formerly they were imbedded in plaster of paris on the bed of the press.

When the "etching" solution has remained long enough on the plate it is soaked off with a soft, damp sponge and the surface moisture removed with a soft, lintless, dry cloth. The plate is first inked with a litho roller and a stiff ink for the shadows, and then inked with a composition roller and a much thinner ink for the middle tones and the delicate shading in the high lights. The paper used to print upon is specially made for collotype printing. The two inks used are usually two shades of the same color, though different colors can be used.

The results produced by collotype printing can have all the gradations of the photograph, from which it is difficult sometimes to distinguish it, though it has the advantage that it is made in permanent printing-ink, so that for fine book illustration and permanent records such as government publications, and for small and choice editions of illustrated work, it can not be approached by typographic methods.

COLLOIDS USED IN COLLOTYPE.

GELATIN.

Gelatin is produced by boiling bones, hoofs, horns and the clippings from hides, calves' feet and other animal substances. It contains about fifteen to twenty per cent of water at normal temperatures, and in cold water will swell up and absorb from five to ten times its own weight of water. It becomes a solution when raised above 90° F. and jellies on cooling. Gelatin keeps indefinitely in the dry state, but dissolved in water it soon putrefies, turns first acid and then alkalin, giving off ammoniacal gas. Alum, alcohol, carbolic, boracic and salicylic acids, thymol, formalin and the salts of zinc act as preservatives of gelatin. Acetic, hydrochloric, sulphuric and oxalic acids dissolve gelatin even when cold. Gelatin dissolved in acetic acid makes a very useful liquid glue. Carbolic acid and alcohol will, when in excess, precipitate gelatin from water solutions. The alkalin bichromates in combination with gelatin render the latter, after exposure to light, insoluble and incapable of absorbing water — this action being the basis of nearly all the photomechanical printing processes. Chrome alum and tannin render gelatin insoluble, though capable of absorbing water. Gelatin heated for a long time loses its swelling property and is called metagelatin.

ISINGLASS.

The purest form of gelatin comes from the fish and is called isinglass. The best quality is produced in Russia from the sturgeon. In the United States it is made from several kinds of fish, including the sturgeon. In the East Indies they produce an isinglass from seaweed which is called agar-agar. Many collotype printers prefer isinglass to gelatin and it is sometimes used in the enamel process.

FOUR-COLOR ROTARY PHOTOGRAVURE.

Van Dyck Gravure Co., New York.

Courtesy of the National Art Co.

PHOTOGRAVURE.

BY ART LOVERS

RECOGNIZED AS THE MOST BEAUTIFUL OF ALL PHOTOMECHANICAL PROCESSES.

Intaglio engraving was the aim of the first experimenters seeking methods of applying photography to the printing-press. And a remarkable thing about it is that the methods they worked out as pioneers have not been greatly improved upon since, at least in the fundamental principles. When Nicephore Niepce, in 1824, coated a metal plate with a solution of asphalt and exposed it to light under a positive engraving and then developed and etched that portrait of Cardinal d'Amboise, he had discovered the whole application of photography to intaglio engraving.

So it was with photogravure. When William Henry Fox-Talbot, October 29, 1852, received his patent "For engraving pictures, obtained by photographic processes on steel plates; the engraved plates can be printed from," he had laid down the principles of photogravure as it is practiced to-day. And when in the same patent: "To produce the effect of engraved lines," he impressed the image of a piece of gauze "upon the gelatin prior to the image of the object required being formed," he had discovered the principle which makes rotary photogravure possible in our time.

Talbot covered a metal plate with a thin film of bichromatized gelatin, exposed this to the action of light under a positive, washed away the unhardened gelatin and etched the plate. In his patent of April 21, 1858, he improved on this idea by dusting the gelatin with a powdered resin and etched with perchlorid of iron, just as we do to-day. He also took a mold from his developed gelatin plate in gutta-percha and produced an intaglio printing-plate by electro-deposition, the principle on which some of the finest photogravures are now made.

There are at present two methods of photogravure in use, as Talbot devised them. One process produces what are known as "bitten" plates, the other as "grown" plates. A bitten plate is one in which the photographic image is produced on the metal plate, and the latter etched or bitten with an acid or mordant. Grown plates are electrotypes from either silvered glass plates or silvered copper plates, on which a bichromatized-gelatin image has been produced in relief by photography. Bitten plates are more common, while grown plates are used by Goupil and many of the large art-publishing houses of Europe. The regular rolled or hammered copper is used for the bitten plate, while the grown copper plate, being the product of electro-deposition, formerly there was a danger that the first copper deposited would be harder than the rest, so that the roller pressure of printing would curl the plate and in attempting to flatten it again it would break. Electro-deposition is now so far under control that this difficulty is no longer an objection to the grown plate.

Talbot began with steel plates, which he etched with bichlorid of platinum. Later he turned to copper and perchlorid of iron, just as we use at present. The writer has before him a proof from one of Talbot's early plates. It is a remarkably fine result, except that the blacks in the proof were not entirely solid. A mezzotint engraver could have corrected this fault readily, but Talbot relied entirely on his process for results.

IMPROVEMENTS BY CARL KLIC.

Photogravure being the most artistic of the photomechanical processes it was natural, therefore, that it should attract the attention of artists, who have done so much to perfect it. In fact one who has not natural artistic feeling or careful training will never distinguish himself at photogravure. It also naturally follows that photogravure is most successfully practiced in the cities possessing art schools.

To Carl Klic, a painter from Bohemia, born in 1841, we owe most of the improvements found in photogravure as practiced to-day. Klic came to the work with a splendid

training. The son of a chemist, he was himself a practical chemist. His artistic bent brought him to study at the Academy of Painting at Prague. He subsequently tried his hand successfully as a photographer, lithographic designer, and as a caricaturist on *Der Floh* and other papers. Having owned a photographic studio at Brunn he dreamed then of the possibility of printing from the photographic negative in permanent printing-ink. He first mastered collotype, and then began — about 1873 — experimenting with intaglio work on zinc. It was about 1875 that he hit on the idea of combining a carbon print with an aquatint grain.

A peculiarity of Klic was that he never patented any of his inventions, preferring to keep them secret, so that it is difficult to give dates for any of his doings. In 1879 he did make public something of his methods of photogravure. He sold the process in Vienna to Victor Angerer, and it became the foundation of great art printeries that have made Austrian photogravures the envy of processworkers everywhere.

Many experimenters were then at work on photogravure, using copper instead of steel and zinc, and using perchlorid of iron as the mordant. It is said that in 1881 Klic had become completely successful in using a carbon transfer for getting his negative resists on copper. By this means all soluble gelatin, which had made his previous work uncertain, was eliminated.

GRAIN DIRECT ON THE COPPER PLATE.

Talbot coated the plate with bichromatized gelatin and afterward laid an aquatint grain upon the gelatin before biting. Klic now laid on the copper a grain of finely powdered bitumen which he fixed to the plate by heat. Upon this grain he transferred a developed carbon print. This grain secured the carbon film to the plate, a feat which other experimenters had found impossible, as the carbon transfer would, on drying, lift clear from a polished copper plate. It was to prevent this that Talbot gave his steel plates a tooth by a preliminary etching before coating with gelatin.

Klic also carried out the etching with successive solutions

of perchlorid of iron of different strengths, beginning with the strongest, which bit through the thinnest parts of the film, the shadows in the plate, while the weakest solution of iron was necessary to penetrate the thickest parts of the gelatin covering. This is our photogravure method of to-day. How simple it all seems, and yet how many years of patient experimenting it required. Many names of experimenters and processes could be given, but only Carl Klic's improvements on Talbot's inventions have survived.

ELECTROTYPING A DAGUERREOTYPE.

Daguerre had no sooner unfolded his marvelous method of recording camera images on a silvered copper plate than the brightest brains in every country began to study how this copper plate could be printed from. It was natural that they should try etching the daguerreotype plate.

Electro-deposition of metals was discovered just about 1839, the time that the daguerreotype was given to the world. Attempts were made immediately to see if by electro-deposition, on some parts of the plate, a daguerreotype could not be printed from. These experiments continued until about 1853-4 — when Paul Pretsch in Vienna and A. L. Poitevin in Paris showed proofs from plates that had been made by electro-deposition on a film of bichromatized gelatin, which had been exposed to light, swelled in water and reticulated by chemical treatment.

ROTARY PHOTOGRAVURE IN 1854.

As an illustration of how little there is new under the sun, at least the photographic sun, it might be mentioned here that Paul Pretsch patented his method of making photogravure plates on November 9, 1854. On August 11, 1855, he received another patent for applying his process to the engraving of copper cylinders, copper or other suitable plates engraved by the processes set forth, and are used, he said, " for the formation of cylinders to be employed in calico and similar printing." To-day men are seeking patents on methods of applying photography to the engraving of copper

rolls for printing, thinking that they have discovered something new. They are making in New York daguerreotype images on silvered copper rolls, developing them with mercury and etching them successfully — the idea which was tried out for years after 1840 and pronounced impossible.

PHOTOGRAVURE MAPS.

Poitevin was more successful with his process which he patented December 13, 1855. So also was Mariot of Vienna, for in 1869 portions of a map of Austria-Hungary were produced by grown photogravure plates. In 1872 was begun a map of central Europe consisting of 380 plates, and later another map of 720 plates. The publication of these maps in Vienna attracted the attention of all governments, so that Mariot's process of photogravure has since been used in many European countries for mapmaking, while Major J. Waterhouse perfected the process for government use in India.

The writer invented in 1881 an original method of photogravure which since that time would have saved the Federal Government at Washington hundreds of thousands of dollars yearly in map engraving. When Captain Sigsbee was in charge of the Hydrographic office he wanted this method adopted, but the "board" which passes on improvements decided that a photographic method would "distort." The facts are, in copying foreign engraved maps, photogravure would give the Government an absolute facsimile, while the present method of tracing and retracing by hand leads to innumerable errors. And so the United States Government still remains behind other countries in mapmaking.

KNOWLEDGE OF THE CARBON PROCESS NECESSARY.

As before stated, the Talbot-Klic method is the one most practiced and will be here described. The carbon process is a most important feature of this method, but as it is a purely photographic process outside the scope of this book, which treats only of photography applied directly to the printing-press, we can only refer briefly to the carbon process here.

The student is referred to the excellent manuals published on the subject.

Carbon tissue for photogravure is purchased from a dealer in photographic supplies. It comes in rolls 2½ by 12 feet and consists of a strong paper evenly coated with gelatin containing a pigment either brown, red, or sepia. The first color is the one most used, as it shows stronger on the copper. This tissue is sensitized in bichromate of potash, dried, exposed to light under a positive, transferred while wet to the copper plate, and treated on the back with warm water, which dissolves the gelatin unhardened by light. The paper support is stripped off and the soluble gelatin washed away, when the image will be found on the copper in gelatin photogravure relief corresponding to the lights and shades of the positive through which the light acted. Where the positive is densest, the light penetrated least and the film of gelatin is consequently thinnest. Where the positive was most transparent, the light acted to the greatest extent, and the carbon film is thickest. When this carbon image on the copper plate is dry and chlorid of iron is applied to it, the iron solution penetrates the thinnest parts of the gelatin resist first, and therefore etches the plate most under these parts. Where the gelatin resist is thickest, corresponding with the high light of the positive, the iron has the least effect on the copper, and the etching is slightest.

We will consider only the additional information a carbon worker must possess to undertake photogravure.

THE NEGATIVE MOST IMPORTANT.

No matter which method of photogravure is adopted a perfect photographic negative is most important. Usually great care is taken in its retouching. This consists not only in adding shades to the negative by working over the varnished film with soft lead-pencils but in removing shades by scraping with a surgeon's scalpel. Gelatin dry plates are almost universally used in making photogravure negatives. The gelatin film being too slippery to hold pencil-marks, a few drops of turpentine are rubbed over the spot to be

retouched and allowed to dry, when fine grains of resin are precipitated by evaporation of the spirit, giving a splendid "tooth" for holding the pencil touches. Should there not be enough grain a little resin is added to the turpentine. When removing shades from the negative the scalpel must be kept as sharp as possible, and the gelatin film scraped away slowly until the desired shade is reached.

A REVERSED TRANSPARENCY REQUIRED.

As a regular studio portrait negative is frequently supplied for a photogravure plate, reversed negatives will not be considered here, but only reversed positives, and a reversed positive must be had for the reason that the negative print from it on carbon tissue is printed right. This tissue is reversed on the copper printing-plate, which gives an etch in reverse on the copper, and consequently the proof from the copper is right.

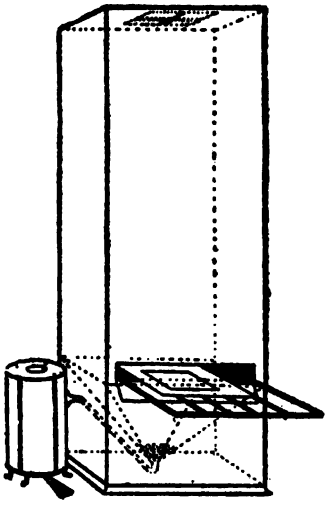
If the photogravure is to be a different size from the negative furnished, then the positive must be made in the camera, and a slow-working dry plate had better be used. Those familiar with collodion emulsion can make, by that method, beautiful transparencies in the camera. And so also can perfect transparencies be made with proper collodion and a silver bath.

The transparency most used by photogravure-makers is secured by the carbon process and special transparency tissue is supplied for that purpose. The carbon transparency is made on a glass support, and can be retouched more easily than the negative. It can be vignetted, skies introduced, and improved in many ways by an artist. It should have more contrast than required in the photogravure print. Strips of lantern-slide binding-tape should be pasted on the back of the glass to mark the exact dimensions of the picture required in photogravure.

THE GRAINING-BOX.

The principle governing the graining of the copper plate is this: The air in a box must be charged with fine asphalt dust, which is allowed to settle on the plate placed near the

bottom of the box. The longer the plate is allowed to remain the greater and finer the quantity of dust. Several kinds of graining-boxes are in use. Small boxes are shaken vigorously to raise the cloud of dust. Larger boxes are mounted on trunnions and revolve several times before coming to rest, while the most satisfactory box is shown in the diagram. It should be several inches wider inside than the largest plate to be grained, and three times the height of the width. The bottom is filled completely with a square zinc funnel, the bottom of which connects with an air-pump outside of the box. The top of the box is covered with fine muslin to allow the escape of the air when the pump is at work, but at the same time confine the asphalt powder. The door to the box is just over the top of the funnel, and the plate rest, in the shape of an open frame, slides on cleats at the sides of the box.



GRAINING BOX.

COPPER AND ITS PREPARATION.

The copper plates had better be purchased polished and beveled, for several reasons. The dealer has selected special metal for the purpose, and he has the machinery and tools for properly beveling and polishing. There is too great a danger of scratching a valuable plate if the beveling is done after the etching. Photogravure copper is usually softer than that used by relief-plate engravers; it etches readily and is usually steel-faced before being printed from. To free the copper from grease it must be heated slightly and placed in a dish containing clean potash solution for a few minutes. It is then rinsed under the tap, and to free it from stain it is laid in a dish of one-per-cent sulphuric acid and

swabbed with a tuft of cotton. Should it still show signs of greasiness, when water is flowed on it, then go over the copper with whiting wet with water to which a little ammonia has been added. Wash the plate with cotton under the tap to remove all traces of the whiting. Dry the plate quickly, when it is ready for the asphalt ground.

GRAINING THE PLATE.

Asphalt finely powdered is sold for this special purpose. Use plenty of it in the box and see that the latter as well as the powder is perfectly dry. The room in which the work is being done should be free from drafts that might disturb the grain on the plate when removed from the box. Practice laying a grain or ground first with a glass plate. Blow up the powder in the box. Wait ten seconds for the coarsest grains of powder to subside. Open the door carefully and slide in the glass plate; allow it to remain say five minutes and examine the deposited grain with a magnifying glass. Blow up the powder once more, wait ten seconds and insert another plate in the box for say fifteen minutes, when you will find the grain about what is desired. If too much grain, give less time in the box, remembering that you can always add to the grain deposit by placing the plate in the box again and again if necessary. Should there be too much grain on a copper plate it must be washed off completely and the plate cleaned and grained anew. After a few trials the precise time to elapse between blowing up the powder and putting in the plate and allowing the plate to remain in the box to get the proper ground will be determined.

When the proper ground is secured the plate is held with a pair of pliers. A piece of blotter between the upper jaw of the pliers and the copper keeps it from injuring the latter. The plate is very gently laid over an even heat until the color of the grain changes from a light fawn color to a dark glossy gray, when the plate is allowed to cool.

SENSITIZING THE TISSUE.

With the carbon tissue comes full instructions for sensitizing, which consists in cutting a piece of tissue one-fourth

inch larger each way than the size of the engraved surface. This should be plunged paper side down into a bath of one ounce of bichromate of potash to twenty to thirty ounces of water and five to ten drops of ammonia. Air-bells are brushed from the gelatin face with a soft camel's-hair brush, then the air-bells are brushed from the back. The tissue will curl at first, but will soon flatten out. The temperature of the bath should not be over 60° F. In three minutes the tissue is taken out and laid face down on a sheet of plate glass that has been previously polished with talc, or a clean, glossy ferrotype plate can be used in place of the plate glass. The surplus water is pressed out from between the gelatin and the glass or ferrotype with a squeegee. The tissue is then dried as quickly as possible without melting the gelatin. When dry it will spring from the plate of itself. It is now sensitive to light and must be placed behind the positive in the printing-frame and exposed to light. Mark on the back of the tissue which is the top of the picture.

TIMING THE EXPOSURE.

Practice will be the only guide to the proper exposure. But the strength of the light must be measured with an actinometer such as carbonworkers use and of which there are many different patterns on the market, because no change is visible on the carbon. After exposure the film is taken from the printing-frame and, as is customary with even expert operators, this first print is used for trial only and is developed on a sheet of plate glass. If the exposure is found correct, a second piece of tissue is exposed exactly as the first one and this is put with the grained copper plate in a dish of cold water, the air-bubbles being carefully removed with the camel's-hair brush. When the tissue begins to flatten out, the gelatin tissue is brought into contact with the grained plate, care being taken that the top of the tissue is on the top of the plate. Remove both from the water and see that the corners of the tissue register with the pencil-marks previously made on the plate, then squeegee the tissue securely to the plate. Blot the surplus moisture from the

back of the plate and place it in a horizontal position for ten or fifteen minutes to set.

DEVELOPING THE IMAGE.

After the tissue has set put it in a deep bath of water of about 100° to 110° F. In a few seconds the layer of soluble gelatin next to the paper backing will begin to soften, when the paper can be gently stripped off and the development of the negative resist begun. The light-hardened gelatin being in contact with the grain will remain, while the unhardened gelatin will be dissolved by the water, which should not be heated above 120° F. The warm water can be poured from a pitcher over the plate and local development brought about by regulating the height of the falling water or the continuance of the stream on one spot. The point to be observed in developing is that the thinnest possible layer of gelatin must remain upon the deepest shadows where the film will be thinnest. All soluble gelatin being removed, cold water is added to the bath so as to reduce the temperature gradually, and the plate is finally washed well in cold water. It is then whirled to get rid of all the water possible and allowed to dry spontaneously without using heat, in a place free from dirt. To hasten the drying, the plate may be flowed with water and alcohol equal parts, gradually increasing the amount of alcohol until alcohol alone is used. It can be whirled again and allowed to dry slowly. If the drying is hurried, the resist may lift from the plate. When dry, the margins, edges and back of the plate are carefully covered completely with either an asphalt or shellac varnish, and the plate is ready for etching.

ETCHING SOLUTIONS REQUIRED.

Chlorid of iron is the mordant used for etching, and it has this peculiarity: that a saturated solution will scarcely penetrate the gelatin resist, while the more it is diluted with water the quicker it will be absorbed by the gelatin and reach the copper plate. Advantage is taken of this property by using chlorid of iron solutions of different strengths.

Chlorid of iron is purchased at 40° strength, Baumé's hydrometer, at a temperature of 70° F. Four other solutions are prepared by dilution with water until they register with a Baumé hydrometer 38°, 36°, 34° and 32°, at 70° F. The bottles are marked, and just before etching five dishes are placed side by side and sufficient solutions from each of the bottles poured into the trays to more than cover the plate when placed in it.

ETCHING.

The copper plate with the gelatin resist, thoroughly dry, is first laid in the dish containing the 40° solution, and air-bells brushed from the surface with a flat camel's-hair brush. The tray is rocked slightly, and it will be noticed that the iron is beginning to attack the copper in the deepest shadows, or where the resist is thinnest, by a darkening of the copper. The time for etching depends on the subject, the resist and the temperature of the solution, so rules can be laid down only that from one to two minutes should be sufficient for the first bath, when the plate is transferred to the 38° bath for a less time, then to the 36° bath, and so on until the discoloration of the plate extends to the thickest part of the resist, when the plate is at once plunged into a bath of potash which stops the action of the mordant and softens the gelatin resist so that it can be brushed from the plate and the grain ground removed with turpentine and benzin.

PROVING AND REETCHING.

A proof can now be pulled from the plate, and if it should not be satisfactory the plate may be cleaned and another grain ground laid on it as in the first place, and by stopping out the high lights and reetching shadows or backgrounds the plate may be darkened wherever desired. Here is where the skill of the artist is required, and this final treatment is what makes one photogravure superior to another. It would be just as easy to tell a painter how to lay the colors on his canvas as to describe the reetching of a photogravure.

One improvement that is not known is that the most expert artist in photogravure in America, at this stage,

regrains the plate, lays an enamel ground just as half-tone etchers do, and with the same solution; registers the positive again perfectly on the plate, prints through the enamel, and without burning-in or development retches the plate just as he wants it; cleans off the plate for a proof, and if he thinks he can further improve it, repeats the enamel coating and the etching.

This is the last word in photogravure.

STEEL ETCHING AND STEEL FACING.

MERCURY MORDANT FOR STEEL.

One of the best of the many mordants which the writer has used on steel is the following: In a glazed stoneware vessel put sixteen ounces of water and add powdered bichlorid of mercury and one-fourth ounce of powdered alum. Put the vessel over heat and stir with a glass rod until a solution is had. When this is cool, add one ounce of alcohol and the mordant is ready for use.

SPENCER ACID FOR ETCHING STEEL.

The secret of the Spencer acid used by steel engravers is as follows:

A. Nitric acid, C. P.....5 ounces
Distilled water .....5 ounces
Pure metallic silver.....1 ounce

B. Nitric acid, C. P.....5 ounces
Distilled water .....5 ounces
Mercury (quicksilver) .....1 ounce

After making these two solutions separately, mix them and keep the mixed solution in a glass-stoppered bottle. When using it can be diluted one-half with distilled water. When a little of this solution is poured upon a steel plate there is no action. It is necessary to bend a strip of zinc so that one end comes in contact with the bared steel and the other end dips into the Spencer acid on the steel; this generates a galvanic action which starts the action of the

acid immediately, when the zinc can be laid aside and the liquid continues to corrode the steel until it is exhausted. The steel engravers' method is to absorb the spent acid with blotter and pour fresh acid on the steel.

STEEL-FACING COPPER PLATES.

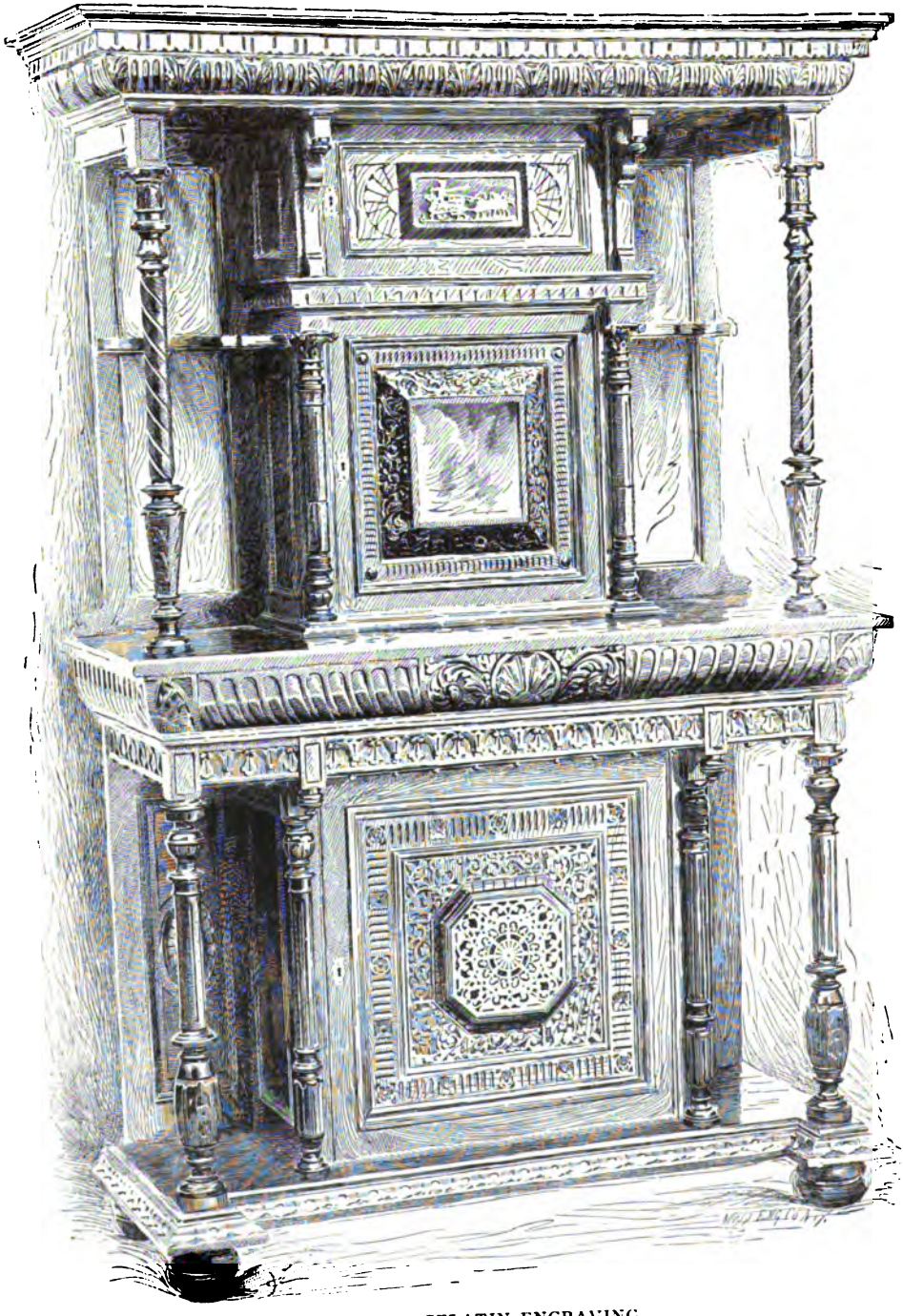
Owing to the large editions usually required from delicate copper photogravure plates it is customary to give the printing surface a protective coating of a film of iron as thin as a soap-bubble though as hard as steel. This steel facing, as it is called, had better be done by an electrotyper as the solution from which the iron is deposited is difficult to keep in condition when used but seldom.

The outfit for steel deposition consists of a depositing tank with its solution, an iron plate for an anode and a small dynamo or batteries. It is better to consult a dealer in electrotyping supplies for advice as to the batteries or dynamo, who will be guided by the size of the plates and the number of them.

One of the simplest of the iron depositing solutions is the one recommended by Mr. Thomas Huson and is as follows:

Water	40 ounces
Chlorid of ammonium	2 ounces
Double sulphate of iron and ammonia	1 ounce
Protosulphate of iron	1 ounce

The salts are to be dissolved in the water and the solution filtered just before use. The important feature of this work is to get the surface of the copper absolutely clean with whiting and water in order that the iron film will be evenly deposited. The deposition should not take more than fifteen minutes, and to keep the steel facing from rust it must be kept covered with oil or beeswax.



SWELLED GELATIN ENGRAVING.
Moss Engraving Company, about 1883.

THE PHOTOELECTROTYPE PROCESS,

COMMONLY

TERMED THE "WASH-OUT" PROCESS IN AMERICA AND LEIMTYPE IN GERMANY.

The photoelectrotype process was one that about 1880 produced the best photoengravings, and it did not seem that it could be superseded. It is now only a memory, and but few of the old engravers are left to tell of the procedure.

It was the method used to reproduce, among other books, the entire Encyclopedia Britannica, and also a Webster's Unabridged Dictionary. The publication of those works alarmed compositors, who feared that the reproduction of standard works, in any size, by this photomechanical process would bring ruin to the typesetter and some publishers.

As this slow method of engraving has some good qualities it is liable to be rediscovered, as so many photo processes are, so a brief résumé of the process is given here.

The most successful method may be said to have originated with William Mumler, of Boston, who obtained a patent on it May 18, 1875. The invention has frequently been credited to J. Husnik, of Prague, who received a British patent on January 1, 1887, twelve years after Mumler was successfully working the same process in the United States. Husnik called his invention "leimtype."

The principle of the process lies in the destruction of the swelling property in gelatin; sensitizing this gelatin with a bichromate and flowing it over a level surface so that it may dry into sheets about one-sixteenth of an inch thick; exposing one of these sheets under an intense negative until the light hardens the gelatin film through to the back. The exposed film is then secured with shellac or gutta-percha to a zinc support, and the gelatin unhardened by light is washed out with a brush and an alkaline solution from between the light-hardened lines of the image, hence the name, "the wash-out process." After this washed-out film is dried it can be printed from direct or an electrotype plate

made from it. This was called the single wash-out process, to distinguish it from Mumler's and Husnik's methods.

It might be said of Mumler, in passing, that he was also the originator of the spirit-photography humbug that fooled Horace Greeley and many scientists at the time, and when revived, as it is occasionally, continues to deceive apparently intelligent people.

DOUBLE WASH-OUT PROCESS.

Mumler and Husnik both found it difficult to get the strongest sunlight to penetrate through to the back of the film without lateral action, so they both hit on similar methods to overcome this undercutting of the light rays. Mumler, after washing out the exposed film the first time, filled in the sunken portions, where the unhardened gelatin had been removed, with a black paste something the nature of shoe blacking. Then the film was exposed to light for a longer period than the first time, the black paste washed away and the underexposed gelatin under it. From this second washing it was called the "double wash-out process." Husnik, instead of rubbing in the black as Mumler did, and then wiping the surface clean as a card plate printer does, painted black in between the lines with a fine hair pencil.

One of the disagreeable features of this process was the offensive odor of the gelatin when fit for use. It was literally, what the workmen termed it, "rotten." And this "rotting," as it was called, was produced by long "cooking" at a temperature of from 120° to 150° F. The time required being from fifteen to forty-eight hours, and the proper amount of cooking was determined when the odor reached its most offensive stage.

COMPOSITION OF WASH-OUT GELATIN.

It is probable if the photoelectrotype process were in use to-day that a common glue combined with fish glue would be used instead of the gelatin and albumen formerly thought

necessary. The formula given here is as simple a one as was found practicable:

Nelson's No. 2, or Cooper's common gelatin	4 ounces
Water	10 ounces
Potassium bichromate	120 grains
Water ammonia	30 minims
Glycerin	1 ounce 2 drams
Albumen	1 ounce

The gelatin is put into the ten ounces of water and allowed to soak up the water. It is then put into a double cooker with an outside vessel of hot water so regulated that the temperature shall range about 130° to 140° F. After twenty-four hours of this temperature the gelatin should have lost all its swelling property. While the rotted gelatin is still hot, add the 120 grains of potassium bichromate in a finely powdered state, stirring the gelatin at the same time. Add the thirty minims of ammonia, then the one ounce two drams of glycerin and the white of one egg; filter through muslin.

Care must be taken in the amount of glycerin used, for the more glycerin the easier the light-hardened gelatin can be washed away, while too little glycerin will leave the film brittle.

MAKING THE SHEETS.

The gelatin is then molded into sheets by using cases similar to those used by an electrotyper for wax, except that the bottom of the photoelectrotyper's case is made of plate glass surrounded with a wooden frame, beveled outward and about an inch deep. The plate glass on the bottom of the cases is waxed and the cases laid on a level table, when the gelatin, just warm enough to be in solution, is poured in to the depth of about half an inch. When the gelatin is jellied so that the cases can be moved without injury to the gelatin they are put into a drying-room where filtered dry air is drawn through by any convenient means. The gelatin in the cases should give up its moisture in two days,

though if it requires three days it will not injure the films. When they are dry they strip easily from the case and are ready for exposure to light in a printing-frame.

PRINTING THE IMAGE AND WASHING OUT.

The reversed negative must be as opaque as it is possible to make it, while the transparent image must be absolutely so. The smooth side of the film is placed next to the negative film in the printing-frame and the exposure made to sunlight at the end of a box from three to six feet long, depending on the size of the printing-frame. The object of this box is to permit only light rays to penetrate the film at exact right angles. After an exposure of, say, ten minutes to sunlight, the frame is taken into the darkroom. Should the gelatin show a tendency to stick to the negative, this may be overcome by rubbing the negative film with talc and the gelatin film as well.

The brushes used to wash out the unexposed gelatin between the lines can be fine bristle clothes-brushes. The principle is that a broad brush having a good surface area will not permit the bristles to sink too far below the surface, though narrow brushes are preferred by skilled workers. Three trays are necessary — one for hot water, another for cold water, and the third for wood alcohol. In the cold water tray is laid a sheet of glass. The exposed gelatin film is drawn through the same tray of cold water, face up, and as soon as it is over the glass plate both are drawn out of the water quickly and the gelatin film squeegeed to the glass, to which it quickly adheres by suction. The brush is first dipped in the alcohol and the surface of the gelatin cleaned of talc and any possible grease; the brush is dipped in the hot water and the surface of the gelatin scrubbed briskly with it, being sure to go over the whole surface evenly. It is best to use a circular motion with the brush. Almost immediately the design will show in slight relief. When it has been washed out sufficiently give the plate a quick rinse under the tap; with a palette-knife strip the film from its glass support and plunge it quickly into the

wood alcohol, where it becomes milky in appearance. The alcohol absorbs the water from the gelatin in about fifteen to twenty minutes, when the film is taken out and either put in the drying-room or fanned dry.

THE SECOND WASH-OUT.

When the film is dry it will be found that the relief is not quite sufficient for an electrotype, so the washed-out parts are filled in with a good shoe blacking and the surface polished off just as a copper-plate printer handles a steel or copper plate. In fact, it is likely that plate printing-ink and a polish with powdered magnesia would answer admirably. The plate is again exposed to light in the printing-frame under a sheet of clear glass and at the end of the long box for, say, twenty minutes, when it is removed from the frame, and, with thick shellac, attached to a glass or metal support. A brush is dipped in the wood alcohol and the blacking loosened from between the lines. Then the film is scrubbed vigorously with a brush and hot water until sufficient relief is had, when it is rinsed and quickly plunged into the alcohol to stop the softening action of the water on the film. The alcohol loosens the shellac so that the film is easily removed and dried, when it is attached to its final zinc support with shellac.

A proof is pulled from the plate and any blemishes engraved out of it, and then it is turned over to the electrotyper. In case of any line or dot being lost in the wash-out gelatin the electrotype-finisher will punch up the plate from the back and supply it.

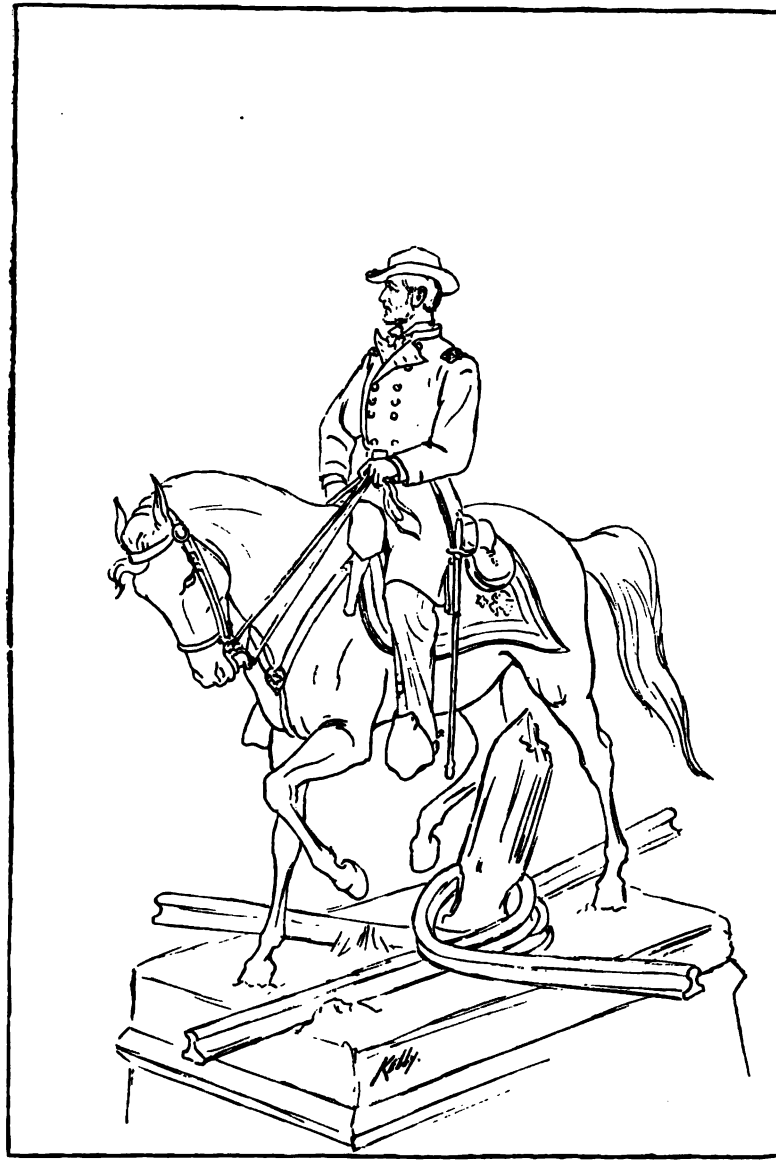
The shellac used to secure the gelatin film to its supports is merely shellac that has been soaked in alcohol until it becomes a thick paste which is softened by heat before using. For a temporary support use a smooth sheet of zinc, from which the film can easily be removed later by the use of a sharp palette-knife between the shellac and the zinc, when the film will split off.

For a permanent support the surface of the zinc is roughened with sandpaper to which the shellac adheres

firmly. Rubber, gutta-percha and even strong glue have been used to secure the gelatin-relief film to its support.

Large editions have been printed from the original gelatin film without electrotyping. The gelatin was, however, after washing out and dried, either exposed to light from the back for a long time or hardened with a bath of chrome alum. It was also the custom with some operators to expose the back of the film to light for a short time before the first wash-out.

It was said of the washed-out films that they could be filed away for use at any time. Such films in the writers' possession for twenty-five or thirty years are even more brittle than if they were glass, due possibly to the continuing action of the bichromate left in the film and the evaporation of the glycerin.



LINE ENGRAVING.

Globe Engraving & Electrotype Co., Chicago.

RELIEF-LINE ENGRAVING.

WHICH IS

THE MOST IMPORTANT OF ALL THE PHOTOMECHANICAL ENGRAVING PROCESSES.

The engraving of drawings in lines, or the reproduction of type by photoengraving, comprises the greater part of processwork the world over, and still the complaint can be justly made that in most cases either no improvement has been made in this class of engraving or frequently the quality of the work has deteriorated.

The causes for the deterioration can be briefly stated. Line engraving, and particularly the reproduction of type, requires even greater skill on the part of the workmen than half-tone engraving, and still the charge for the work usually does not pay the cost of producing it properly, consequently the work is slighted. Then the same collodion is used for line-negative making that is used for half-tone negatives, which should not be done. And worst of all, the line operator uses "cutting" solution on the negative which destroys the character of the copy. To prove the last charge, examine a negative of a line subject that has been "cut" wherever two lines cross, and notice how the sharp corners have been dissolved away, never to be restored by any succeeding operation.

SPECIAL LINE COLLODION.

The collodion used for line engraving should be a more contrasty one than that used for half-tone negatives, and therefore should contain but little bromid salt. The sensitiveness of the iodids was found by the writer to be about in the following order: Iodid of zinc makes the most sensitive collodion, followed by white iodid of ammonium, and then cadmium, potassium, sodium, and least sensitive was iodid of uranium. Iodid of uranium gives the greatest intensity and so do the iodids of zinc and potassium; but they seem

to put the silver bath out of working condition quicker than the iodids of ammonium and sodium, so that a reliable working formula for line collodion was found to be the following:

FORMULA FOR LINE COLLODION.

Ether, sulphuric, U. S. P., specific gravity 0.725..	5 ounces
Alcohol, ethylic, 95 per cent.....	5 ounces
Iodid of ammonium, brown.....	60 grains
Bromid of cadmium.....	10 grains
Guncotton (pyroxylin)	70 grains

Collodion preparation is an exceedingly simple operation if the following method is adopted: Take equal quantities of ether and alcohol. For every ounce of the total quantity of these liquids weigh out 7 grains of guncotton, 6 grains of brown iodid of ammonium, and 1 grain of bromid of cadmium. Put the cotton to soak in the ether, dissolve the salts in the alcohol, and then pour the alcohol into the ether, when the cotton will dissolve. Shake well and allow it to "ripen" in a cool, dark place for a couple of days. Filter well through absorbent cotton before use.

POINTS ABOUT COLLODION.

In winter five per cent less alcohol and five per cent more ether can be used to advantage, though as the workroom should be maintained at as near 60 degrees as possible, in winter it is not necessary to change the proportions of the ether and alcohol from the normal. As the ether evaporates first, when collodion becomes too thick more ether than alcohol should be added to dilute it. An excess of ether closes the pores in the film so that the silver salt does not penetrate so well, while an excess of alcohol makes the film too porous and rotten, causing it to tear easily under the tap when washing. Collodion as recommended above should be made up at least once a week, and some of the old and the new mixed before filtering to make the best working collodion.

There are at least fifty-seven different varieties of collodion in use, each operator having his pet formula, but the fewer the ingredients the less complications occur in taking

care of the silver bath and the intensification of the negative which follows. Too much insistence can not be laid on using a proper collodion bottle. One with a glass cap that covers the entire top of the bottle, preventing dust and evaporation, and which has besides a wide base with a recess to hold sediment, is the ideal pouring bottle for collodion. For further points see " Collodion for Photolithography " in this book.

RELIEF AND PHOTOLITHOGRAPHIC NEGATIVES.

All that has been advised in making negatives for photolithography in the chapter on that subject applies to negatives for engraving lines in relief in the matter of cleaning glass, also to the substratum and developer used, only that a slight change is suggested in the collodion, and it is recommended that the silver bath be stronger. A 45-grain bath will be found an improvement for line negatives. Greater intensity is required in negatives for relief engraving, and as they require always to be reversed, information regarding these operations follow.

INTENSIFICATION.

Intensification means the increasing of the deposit on a negative so as to augment its opacity without staining the transparent parts of the collodion film representing the lines or dots of the copy. It is a purely chemical reaction, so that the chemicals and their application should be used with intelligence. Besides the intensifiers recommended in the chapter on negative-making for photolithography, and which can be used for relief-line negatives, the following intensifier is preferred for the present purpose, owing to the extreme opacity of negative produced by it:

Copper sulphate	2 ounces
Potassium bromid	1 ounce
Water, pure or distilled	20 ounces

When the chemicals are completely dissolved in the water the solution can be flowed on the negative that has been previously fixed with cyanid of potassium solution and well

washed. In a short time the image begins to change to a creamy white in color, and when this color has completely penetrated to the back of the film the plate is well washed under the tap and flowed with

Silver nitrate	1 ounce
Water, distilled	20 ounces
Citric acid enough to make solution acid.	

After which the film is again washed. The image is now a deep brown-black in color, which will be found opaque enough for most purposes. To render the film an intense black the operation may be repeated. Other intensifiers may be found by consulting the index.

STRIPPING AND REVERSING THE NEGATIVE FILM.

When the negative is perfectly dry, which is usually done in a heated oven, it is cooled on an iron slab or with an electric fan and flowed with the following rubber solution:

Pure Para rubber, cut into shreds	1 ounce
Benzin or benzol	1 quart

The rubber is allowed to soak in the solvent which can be either benzol or the cheaper benzin until it will, upon shaking, give a solution about the consistency of collodion. There is little danger of having this rubber film too thin; the error is usually in having it too thick. It should be flowed on and off the negative quickly, so as not to get too thick a film. It is allowed to dry spontaneously until the benzin solvent evaporates, which it does quickly. When the rubber is firm to the touch of the finger it is dry and can be flowed with plain collodion made up as follows:

Ether, sulphuric	10 ounces
Alcohol, 95 per cent.	10 ounces
Guncotton (pyroxylin)	120 grains
Castor oil	40 minims

Though the above formula for stripping collodion is the one the writer uses, it should be remembered that there is great latitude in the proportions of the cotton and castor oil.

After ether and alcohol are mixed in equal proportions measure the number of ounces, and if cotton is added in any proportion of from 5 grains to 10 grains to the ounce of the combined ether and alcohol and from 1½ to 3 minims of castor oil is used, any of these proportions will make a good working stripping collodion, the only difference being that the film is thicker as the quantity of cotton is increased. The proportion of castor oil should be increased with the increase in the cotton.

The collodion film can be dried over heat; in fact, on newspapers, where speed in the operations is an important factor, it is customary to set fire to the collodion film as soon as it is set. This burns off the ether and alcohol almost immediately.

DETACHING THE FILM FROM ITS GLASS SUPPORT.

The negative film is now cut with a sharp-pointed knife just outside the image so that it will occupy as little space as possible when a number of negatives are stripped and turned upon the same sheet of glass. In the case of "layouts" or borders where several half-tones are to be inserted in a single frame or border it is customary to cut out the openings in the frame or layout after the film is turned upon its final support.

To detach the collodion film from its original glass support it is necessary to destroy the albumen substratum that has thus far held it secure to the glass. This is done by placing the glasses holding the negative films to be stripped in a tray containing

Water	10 ounces
Acetic acid (30 to 36 per cent)	1 ounce

For hurried newspaper work the acetic acid can be increased until it is one-half the quantity of the solution. This solution will work more rapidly when heated. In from three to five minutes the acetic acid will have penetrated through the rubber and collodion films and have destroyed the film of albumen so that the negative film will be loose upon its glass support. When this is so, the acetic acid is

washed from the negative and a corner of the negative film is raised from the glass with the point of a knife-blade, and then two corners are taken hold of and the whole film slowly stripped from the glass and carefully laid down reversed upon its final crystal-plate glass support, which is lying on a level support, and flooded with clean water so that the stripped film may be floated into its proper position.

Most negative-turners, as the men who strip films are called, prefer that the final crystal-plate glass support be laid on a ground glass fixed at an angle like a retoucher's stand with a light behind. One advantage of this is that particles of grit or dirt are more easily washed down from the glass, and are not held under the transferred film. To squeegee the water out from between the film and the glass it is best to use pieces of lintless blotter cut into squares of 2 by 3 inches. This blotter absorbs the water and does not scratch the film. After the film or films are turned and squeegeed fast to the glass it is allowed to dry.

PREPARATION OF THE METAL.

For line engraving we will only consider the use of zinc. This metal had better be purchased ground and polished. It contains some grease which is removed by placing the metal in a strong solution of caustic potash or lye for a few minutes, washing off the potash and then removing the polished surface, containing the grease, with the end of a piece of engravers' charcoal. Instead of the charcoal fine pumice powder may be applied with a brush or a felt pad. All the grinding of the surface must be done with water.

In Europe it is customary to give the surface of the zinc a matt surface with what is called a

GRAINING BATH.

This bath is composed of water in which is a trace of nitric acid and some powdered alum. The proportion of the

components of this bath has a wide range, though the following will be found to work well:

Water	½ gallon
Nitric acid	1 ounce
Alum, powdered	3 ounces

This graining bath is used in a tray in which the zinc plate is laid and the graining solution allowed to flow back and forth over the plate in order to dislodge the gas bubbles that form. These bubbles can be removed with a flat bristle etching-brush. When the plate receives an even gray matt surface all over, it is removed and washed well under the tap with a clean sponge or tuft of cotton, and it is ready for sensitizing.

SENSITIZING SOLUTION FOR ZINC.

In the whole list of substances known to photographic chemists as being sensitive to light there is probably none as simple, yet delicate and effective, as albumen containing a bichromate. A film of it can be produced as thin almost as a soap bubble on a sheet of metal and still be utilized. It is the most used, least appreciated and most abused sensitizer in the photomechanical printing processes. The following is one method of preparing it properly. The ingredients being

Water, distilled	8 ounces
Albumen, fresh egg	1 ounce
Bichromate ammonia	20 grains
Ammonia water, 26°	8 drops

The albumen of a fresh egg should be beaten with a clean eggbeater until it becomes froth. This is allowed to settle, when it should make one ounce. Four ounces of the distilled water is stirred into the albumen and the bichromate of ammonia is dissolved in the other four ounces. While the albumen is briskly stirred with a glass rod the bichromate solution is slowly poured in, and while the stirring is continued the ammonia is added from a dropping tube until the solution turns to a pale straw color. The solution is filtered

slowly through a tuft of filtering cotton into a clean glass pouring-bottle, when it is ready to sensitize the zinc plate.

SENSITIZING AND PRINTING THE ZINC.

After the zinc plate is prepared for sensitizing by polishing with charcoal as described, it should not be allowed to dry before sensitizing. To keep it any length of time before sensitizing, it must be put in a tray and covered with clean water. While the zinc plate is still wet with clean water it is flowed with the sensitized albumen in the same manner as collodion is flowed, except that the solution, after covering the plate and driving off the water that was on the plate, is allowed to run to waste. The zinc is coated once more from the diagonally opposite corner and the solution again allowed to waste. This coating is repeated four times. The last two coatings may be drained from the plate into the filter to be used later. The plate can now be fastened face down in a whirler and dried face down or it can be held almost vertical over heat so that surplus solution can drain off. No matter how it is dried, three points must be watched. First, that no air bubbles are allowed to rest on the plate; secondly, that it is dried free from dust particles; and lastly, that it is not heated above that which the back of the hand can withstand, as overheating will coagulate the extremely thin film of albumen. Of course the sensitizing and drying operations are performed in a room lighted only by a yellow light. Though gaslight or an incandescent lamp has little influence on the bichromatized albumen film, still it is better to use only yellow light.

EXPOSING TO LIGHT IN THE PRINTING-FRAME.

When the sensitized plate is cool it is ready for exposure behind the negative. Both the negative and plate should be the same temperature to avoid sweating when in contact. The regulation engravers' printing-frame is used, and its thick glass is cleaned carefully. No particles of grit should get between the glasses, or one or both of them may be broken under the great pressure required to produce absolute contact. A backing sheet of pure gum rubber or a soft and thick

felt or woolen blanket behind the metal plate will give the requisite elasticity and prevent much glass breakage.

The time of exposure can best be determined by experiment, for the strength of sunlight varies even with the latitude, the season of the year and the time of day. So also does the strength of the electric light change with the carbons, current, style of lamp used, and distance of the sensitive plate from the arc. A few trials will teach the proper exposure. With an intense negative there is great latitude in exposure, so there is little danger of overexposure except that it may thicken the lines.

INKING THE EXPOSED PRINT.

There are so many makes of excellent etching-ink obtainable everywhere that no engraver should attempt making his own etching-ink. Ink properly covered from dust and air will keep for centuries, so there is no necessity for fresh ink. Old stiff ink needs only to be softened with a little linseed-oil varnish or a vegetable oil to be made ready for use.

Should a regular etching-ink be not at hand, lithographers' transfer-ink will be found to answer the purpose, and even ordinary printing-ink will work providing it has a little Canada balsam incorporated thoroughly with it.

For long service a smooth skin lithographic roller is best; a composition roller lays a smoother film of ink. It is recommended to spread the ink on the warmed plate with a smooth skin roller, and then distribute the ink in intimate contact with the albumen film with a composition roller. The important thing to consider for the best work is to get a thin coating of stiff ink so that the color of the zinc will not be entirely hidden and that the plate is covered perfectly. This can only be accomplished by continuous rolling. Should too much ink be on the plate it can be removed by cleaning the roller and going over the ink with the clean roller.

DEVELOPING THE IMAGE.

After inking the warm plate in a yellow light it is laid in a tray of clean, cold water without allowing any air-bells to

adhere to its surface. The tray can then be taken, if desired, into daylight to develop the image. The image should show, if the coating of ink is thin enough, almost immediately. A good-sized tuft of absorbent cotton is wet with the water and gently drawn over the plate, when the albumen unacted upon by light will wash away from the plate, carrying with it the overlying film of ink. This gentle washing with the absorbent cotton is continued until all the surplus ink is removed, when the image will be found sharp and clean. A good rinsing under the tap will free the plate of any soluble albumen and loose ink. The plate is then dried over gentle heat without permitting any drops of water to rest on the image while drying. Water drops are usually blown from the plate. When the plate is dry it is examined, and any broken lines or dots repaired by retouching with a fine camel's-hair brush and dilute etching-ink. It is then ready for powdering, as it is called.

POWDERING THE PLATE.

Much of the smoothness of the edge of the lines obtained by etching is dependent on the fineness of the resinous powder used as an acid resist, so that too much attention can not be paid to sifting the powder through a silk sieve before allowing it to attach itself to the ink image on the plate. The first resinous or "topping" powder applied is usually a white powder and can be finely ground resin, shellac, dammar or sandarac. This white powder is kept in a well-covered box larger than the largest plate used. Some of the white powder is shaken all over the surface of the warmed plate and brushed carefully in contact with the ink with a broad and soft camel's-hair brush. The surplus resin is removed by brushing with a large wad of dry absorbent cotton until, looking over the surface of the plate held level toward the light and even with the eyes, no powder is seen attached to the bare metal.

It is well now to go over the plate with finely powdered dragon's-blood, in the same manner as the white powder was used, except with a different brush and tuft of cotton. The

dragon's-blood powder fills in between the fine grains of the white powder, and when melted makes a resinous coating more impervious to acid than if the white powder alone was used.

MELTING THE RESINOUS POWDER.

As any of the resinous powders used melt at a temperature of between 250° and 300° F., it is not necessary to heat the zinc plate beyond 300° F. Greater heat might cause the resin to melt and run together where the lines are extremely close together and also injure the zinc. When the image on the metal begins to appear glossy over the heat it is sufficiently incorporated with the ink, and the plate (still gripped with the broad-nosed pliers with which it was held over the heat) is coated on the back, edges and sides with a thin asphalt varnish which is allowed to dry.

ETCHING THE METAL PLATE.

The etching fluid for zinc is nitric acid diluted with water. For the first "bite," as the first etching is called, one ounce of 40° Baumé nitric acid in eighty ounces of water is sufficiently strong. This etching solution is put in a rocking bath, the plate placed in it, and the solution allowed to rock back and forth over the plate until its exposed metal surface is covered with fine bubbles of gas. A flat camel's-hair brush is used to remove these gas bubbles while the bath is kept rocking. The constant movement of the etching fluid over the surface of the plate prevents the further formation of gas bubbles. The oxid of zinc which is left on the plate by the corrosion of the etching fluid is removed at intervals by gentle use of the camel's-hair brush. The plate can be turned occasionally so that the etching fluid washes over it in as many different directions as possible.

The finest lines or dots on the plate must be watched to see that they show no signs of reduction in width, which would indicate that the etching fluid is beginning to encroach on the sides of the lines, which side action of the corrosive liquid is what must be avoided to secure proper etching.

When the progress of the etching is to be examined the zinc plate must be taken out and plunged quickly into water or held under the tap to prevent oxid forming. When the exposed surface of the zinc has been so far dissolved away that the depth can be felt with the finger-nail the moisture may be removed from the plate with a dampened chamois-skin and the etching examined with a magnifying glass. The finest lines or dots in the image are the ones to scrutinize. If they have been reduced at all in width then the etching has proceeded too far, though a slight reduction is made up for in the thickening of the line when printed from later. It is astonishing how slight the depth of etching need be to retain etching powder in the next operation.

THE SECOND ETCHING.

Before proceeding farther with the etching the sides of the lines must be protected from the action of the acid, and this is done by brushing dragon's-blood powder against the sides of the lines in the following manner:

Push the upper edge of the warmed zinc plate through the finely sifted dragon's-blood powder lying on the bottom of the box until a quantity of the powder is scraped up on the upper part of the plate. Hold the plate at such an angle as will cause the powder to slide on the surface of the plate back into the powder-box from the lower edge of the plate, then lay the plate on the edge of the box, and while holding it with its lower edge slightly inclined toward the bottom of the powder-box brush the powder into the box with a wide and soft camel's-hair brush, keeping in mind that you are brushing the powder against the upper sides of all the lines and dots on the plate. Keep up this brushing, with the plate and brush at the same angle, the latter almost vertical, until all of the powder is brushed clean from the exposed zinc that has been etched, except that which is brushed against the upper sides of the lines and dots. Without jarring the plate, which might shake down the powder pressed against the side of the lines, grip the plate with the wide-nosed pliers and hold it over heat until the dragon's-blood is melted and

attached to the side of the lines and dots. Then lay the zinc plate on a cold stone or iron slab to cool. Repeat this operation by brushing the dragon's-blood powder over the image in the three other directions and melting the powder securely in place after each powdering until all four sides of the dots on the plate are protected with dragon's-blood powder.

The etching bath of eighty ounces of solution may be strengthened with the addition of from one to two ounces of nitric acid for the second bite. The bath is rocked as before and the gas bubbles removed when they form. The plate can be brushed more frequently, and the etching proceed until the plate is corroded to over twice the depth of the first bite, when it is taken out, washed well under the tap, the moisture dabbed from the plate with the damp chamois-skin, and the plate dried and examined.

THE THIRD AND FOURTH ETCHINGS.

The warmed plate is again powdered four ways. This time the powder can be banked in considerable quantity against the sides of the lines and the small spaces between the lines completely filled with the powder. The strength of the etching solution is further increased, and the plate can be brushed more frequently while being rocked in the etching bath.

Three bites, or etchings, is usually all that is required to get sufficient depth. Should a fourth etching be desired, the operation of powdering four ways is repeated once more and the acid bath is strengthened still further, all of which can be learned by experience and good judgment better than from pages of description.

Etching machines which impel the etching fluid against the plate at right angles to its surface produce far more satisfactory results than can be had in the method just described, which is termed " tub " etching.

CLEANING THE ACID RESIST FROM THE PLATE.

No better means of removing all of the etching resist from the zinc plate can be found than to heat the plate quite

hot and pour over it some strong lye solution, afterward scrubbing back and front with a strong bristle brush, care being taken that none of the hot lye gets on the skin which it will remove as readily as it does the acid resist. Strong caustic potash or lye has a corrosive action on zinc, therefore it must be washed off quickly under the tap after it has dissolved away the acid resist from the plate. The water is again removed from the cleaned zinc with the damp chamois-skin. The plate is dried quickly to prevent oxidization, and it is then ready for proving; after which it is routed with a machine for that purpose and turned over to the finisher who engraves out any defects, raises the metal where parts of the image have been etched away and softens the lines used in shading with a roulette so that they will grade off to white. The finisher works with the copy and the first proof before him, and the perfection of the finished plate depends on his training, skill and judgment.

ENAMEL ACID RESIST ON ZINC.

One reason a solution containing glue called "enamel" is not used more commonly on zinc, as it is used universally on copper, is because enamel requires to be carbonized before it will become an acid resist and zinc will melt before the heat required to carbonize is reached.

Enamel is used on zinc, however, by observing the following precautions: First, the zinc surface is given a slight grain or "tooth"; chromic acid or citrate of iron and ammonia is used in the sensitizer; a hardening bath is used to make the glue nonabsorbent of water; and lastly, an alcoholic acid solution may be used instead of an aqueous one to etch the enamel-coated plate in. By keeping these precautions in mind enamel can be used on zinc by the following procedure:

GRAINING BATH FOR ZINC.

The grease is first removed from the sheet of polished zinc by laying it in a solution of caustic potash for a few minutes, after which it is washed well under the tap to

remove all traces of the potash from both sides of the zinc. It is then laid face up in a tray containing the following solution:

Water	30 ounces
Powdered alum	1 ounce
Nitric acid	½ ounce

This solution is allowed to flow back and forth over the surface of the zinc while it is brushed evenly with a broad bristle brush. After a few minutes the surface will take on an even, gray, matt surface, when it is washed with a clean sponge under the tap to remove the oxid of zinc.

While the zinc plate is still wet it is flowed with the following

ENAMEL SOLUTION FOR ZINC.

Water	8 ounces
Le Page's glue	4 ounces
Ammonium bichromate	160 grains
Citrate of iron and ammonia	24 grains

Dissolve the bichromate in 4 ounces of the water and add the citrate. Dissolve the glue in the other 4 ounces of water and pour the dissolved salts into it while the glue solution is being stirred. This solution will not keep long, though it works best twelve hours after being made up. The only precaution to use with it is, after development, to remove the water from the enamel by flowing the plate with methylated alcohol several times. Bake the enamel to a light brown.

ENAMEL FOR ZINC WITH HARDENER.

For those who care to use a hardener for the enamel the following formula will be found to work admirably:

Water	10 ounces
Le Page's glue	3 ounces
Albumen, white of a fresh egg	1 ounce
Ammonium bichromate	100 grains
Chromic acid	5 grains

Le Page's glue is not essential. Any good quality fish-glue will answer; in fact, some prefer what is known as

belting cement, as it gives a still tougher enamel. Care must be observed with unclarified glues to filter out the globules of fat that may be seen floating on the surface.

HARDENER FOR ENAMEL ON ZINC.

The hardener used with the above enamel is made as follows:

Water	30 ounces
Ammonium bichromate	60 grains
Chromic acid	5 grains
Methylated, or wood alcohol	5 ounces

The developed enamel-coated plate should rest in this hardening bath for from three to five minutes.

The secret in the use of an enamel on zinc is to use as strong a nitric acid bath as possible, so as to etch the plate quickly and wash the enamel under the tap only when absolutely necessary, as water is liable to soften the enamel.

HALF-TONE WITH TWO-HUNDRED-LINE SCREEN.

Mr. Frederick E. Ives.

Suffolk Engraving Co., New York and Boston.

THE HALF-TONE PROCESS

AS APPLIED TO

RELIEF-PLATE ENGRAVING AND USED IN EVERY LARGE CITY IN THE WORLD.

The term " Half-tone " is a misnomer as applied to the photomechanical method of making relief blocks for the printing-press, for the reason that the word " half-tone " refers only to the intermediate color between the extreme lights and the strong shades of a picture, while the half-tone process of engraving reproduces all the tones of a picture including the high lights and the shadows. The term " similigravure " in French expresses the idea better, but the word " half-tone " has come into the language and will remain.

One explanation of the way the word came into use is that in the early days of the process it was usual to say of it that it " reproduced all the half-tones of the photograph," and this was eventually shortened to the " half-tone process," and as it was used practically first in the United States the word adopted for it here impressed itself on other languages until now " der Halbtoneprozess " is applied to it in Germany and " Demi-teinte proces " is known in France.

Half-tone engraving has come so quietly and modestly into use that no one realizes how extensive is the place in modern civilization it occupies nor the great number of lines of business which are dependent upon it. The universally used half-tone block is responsible for great changes in the manufacture of printing-presses, paper and ink, and in the greatly increased demand for these products has built up immense manufacturing industries with their thousands of workmen making fortunes for their proprietors, while those who brought the half-tone block to its present state of perfection have been satisfied with a bare living.

Some idea of the importance of the half-tone block in business can be had if one contemplates what would happen

if half-tone engraving should stop suddenly. Think of the number of monthly periodicals and weekly publications that would collapse immediately, the thousands of engravers, electrotypers, printers, pressmen, inkmakers, papermakers and allied tradesmen that would be out of employment and the millions of dollars in presses that would go into the scrap-heap. Modern business is so dependent on advertising, and extensive advertising is made attractive chiefly through half-tone illustration, that it will be understood how, through the removal of half-tone illustration, business would lose its stimulus. Still the most serious blow to civilization, through stopping suddenly the making of half-tone engraving, would be in education, for illustrations are, after all, among our chief sources of information. We receive mental impressions from them quickest, and these pictures remain longest in our memories, while they are at present and long will continue to be the only universal language.

WHAT IS A HALF-TONE?

The greatest librarian in this country has asked the writer "How can I distinguish a half-tone from a lithograph or a photogravure. They all appear to be made through a screen." By "half-tone" he meant an impression from a half-tone relief block, by "lithograph" he referred to a planograph print made on the offset press, and by "photogravure" he had in mind a rotary-photogravure. A study of the inserts in this volume with a magnifying glass will help one to distinguish the different processes used. The rotary-photogravure is easily distinguished by its velvety shadows devoid of screeny effect, while in the lighter tones, where the screen is visible, it separates squares of the same area but with varying quantities of ink in the squares. An offset print is usually on a rough-surfaced paper, the half-tone dots having a soft appearance, while the relief half-tone impression is generally on a coated stock with white dots like needle-points in the extreme shadows and a gradation into the most delicate black dots in the high lights. Still an expert will be deceived at times as to the method used in producing an

DARGAVEL WAVY-LINE SCREEN.
John Swain & Son, Ltd., London.

illustration, owing to the applications of the half-tone screen becoming so varied and the printing methods so numerous.

THE HALF-TONE SCREEN.

The early experimenters seeking a method for translating the tones of a photograph into lines and dots, in some approach to the results of the wood engraver, dreamed that it might possibly be done through a grating or screen of some kind, and numerous were the kinds of screens or gratings used. The writer reasoned out that the grating should be one consisting of apertures, and so the first half-tones he made between 1877 and 1880 were made through perforated cardboard.

The half-tone screen used in the making of relief blocks to-day is simply an opaque plane surface through which square apertures are pierced. These apertures are uniform in size, mathematically equidistant, and in area are one-third the area of the opaque plane surface. We owe the present half-tone screen to Mr. Frederick E. Ives, who in the winter of 1885-6 sealed two single-line screens together, and to Mr. Max Levy, who in 1893 perfected the manufacture.

THEORIES AS TO HALF-TONE DOT FORMATION.

An explanation of the action of the rays of light reflected from the object through the diaphragm in the lens and then through the apertures in the screen to form dots of different shapes and areas on the sensitive photographic plate would require extremely complicated diagrams and such a mixture of words and phrases as: "Dioptric image," "penumbral effect," "luminiferous ether," "irradiation," "diffraction," "interference fringes," "halation," "fluorescence," and the "undulatory" and "vibratory" theory of light. All of which will be spared the reader as being beyond the purpose of this book. We will consider only the practical methods employed in making a half-tone block.

Half-tone negative-making is one of the most intricate lines of work in which a photographer can be employed. It

requires a natural taste, or a cultivated judgment, as to tone values, a knowledge of ordinary negative-making and a skill in the use of diaphragms and the manipulation of screen distances that can best be acquired by actual practice.

Added to this must be apparatus as nearly perfect as can be found so readily in the market to-day. There are at least five excellent makes of lenses, any of them rather expensive if would seem, but really sources of much economy from the speed at which they work coupled with their superior definition. A good camera is a most necessary piece of apparatus. One in which the screen support is part of the camera-box and not in the plateholder is to be preferred, for it is not only risky to carry a valuable screen in the plateholder from darkroom to camera, but it is a waste of energy as well. The camera-box, the slides on which it moves, and the copy-board holder must be so rigid that perfect parallelism is maintained at all times between copy-board, half-tone screen and sensitive plate. The mechanism for regulating the distance between the half-tone screen and the sensitive plate, while maintaining perfect parallelism between them, should have a micrometric adjustment. Should a prism be used with the camera, then it must be kept at absolute right angles with the copy-board. The plateholder should be always in perfect condition and the camera-stand arranged to absorb all vibration. It is needless to add that the half-tone screens must be perfect.

THE SCREENY EFFECT IN HALF-TONES.

While on the subject of the half-tone screen some questions frequently asked might be answered. In the first place, the invariable alignment of the dots at angles of forty-five degrees to the sides of the screen is selected because it was found at that angle they were least objectionable. Were they arranged, for instance, horizontally and vertically, they would be most obvious. Would not a grain screen be more pleasing? Grain screens are in use. A most excellent exhibit of engraving through such a screen is shown in this book. It has been found in practice that grain screens do

FIRST PHOTOENGRAVING.

Portrait of Cardinal d'Ambrose, by Joseph Nicéphore Niépce.

Reproduction by Barnes-Crosby Company, Chicago, from a copy in the possession of Mr. Albert H. Walker, New York.

not give in the highest lights and deepest shadows the delicate definitions or gradations of the cross-line screen. Can not screens be made with a less mechanical pattern than cross bars? As the mechanical pattern of the screen is governed largely by the shape of the aperture in the diaphragm, with the ordinary half-tone screen the pattern can be varied at will and has been so changed, but there is no great demand for the change.

Gen. Frederick W. Von Egloffstein's half-tone screens used in New York in 1868 were made with a wavy line, and the results were not so objectionable as the straight lines. Mr. A. Dargarvel, of London, has in use a waved-line screen. A pleasing example of work engraved with it is shown elsewhere.

LIGHTS FOR MAKING HALF-TONES.

The half-tone screen with its transparent openings but one-third of the opaque area offers so much obstruction to the light in negative-making that a strong flood of light is desirable to illuminate the copy. In cases where the subject is to be enlarged, sunlight, if available, is to be preferred. When the copy is large and in colors, such as a painting, drawing, decoration, rug, carpet, wall-paper, or a large surface of any kind requiring even illumination, then there is no light to compare with daylight reflected from a northern sky. So also when making the half-tone negative direct from natural objects. But when the copy is largely the reproduction of photographs, wash drawings and plane surfaces of small dimension, then electric-light illumination is preferred, chiefly on account of its steadiness. In fact no half-tone plant, no matter how extensive its provision for day lighting, should be without electric lamps as a substitute or accessory when daylight fails.

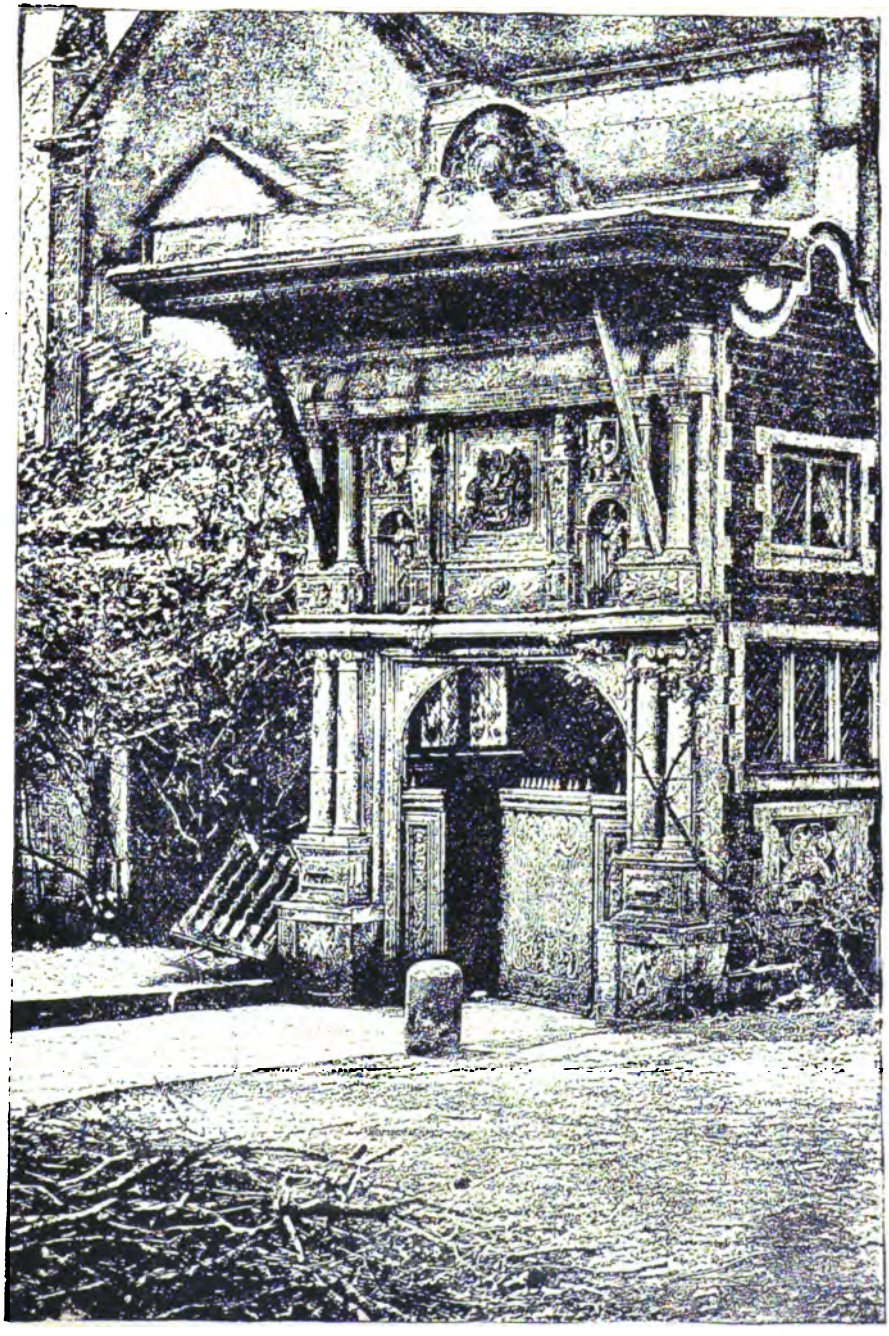
For newspapers, where negatives must be made at night, electric illumination is of course depended on, and it makes little difference whether the engraving plant is located in cellar or garret, providing the ventilation and temperature is right.

Just here we will consider the half-tone collodion. It should possess certain special properties. It must be quick-working. It should give detail in the shadows and still supply strong contrasts. A collodion containing all these properties would be ideal, though it is thus far impossible of attainment for several reasons: The quicker a collodion works, the less contrasty it is; while a contrasty collodion means one that will not give detail in the shadows, so that an adequate half-tone collodion must be one of compromises.

In compounding a half-tone collodion it should be remembered that iodids give contrast while the bromids decrease contrast, at the same time giving greater detail in the shadows. The ammonium salts supply a collodion that can be used soon after making, but will not keep. A collodion made with the cadmium salts will require weeks to "ripen," as it is called when a collodion is in the best condition to use, and a cadmium collodion will keep in a workable condition for months. The quality of the guncotton (pyroxylin) used has considerable influence on the density and coarseness of grain of the negative, so that care must be taken in its selection, though even the best brand will vary in quality at different times.

HALF-TONE COLLODION FORMULA.

The first thing necessary is that the ingredients in a half-tone collodion be pure. Once a reliable maker of chemicals is found he should be patronized, and not forsaken for the first one that offers a cheaper article "just as good." The alcohol must be guaranteed to be a ninety-five-per-cent grain alcohol, the ether should be sulphuric, U. S. P., with a specific gravity of about .725. The ammonium iodid must be U. S. P. in crystals about the color of light-brown sugar, for the reason that collodion made with it ripens quicker — that is, it can be used a day or so after being mixed. The white iodid of ammonium can be used, though it is generally necessary to add a few drops of tincture of iodin to the collodion to ripen it. The cadmium bromid should be in white crystals.



PHOTOENGRAVING OF 1860, PRETSCH PROCESS.

Reproduction by Ransom Engraving Co., Ltd., Winnipeg, Canada.

The proportion of a simple and most satisfactory half-tone collodion is the following:

Ether, sulphuric, U. S. P., 725	10 ounces
Alcohol, 95 per cent, grain	10 ounces
Guncotton (pyroxylin)	180 grains
Ammonium iodid, brown	100 grains
Cadmium iodid	40 grains

The better way to use the formula is to remember that for every ounce of the mixture of ether and alcohol 6 grains of cotton is used with 5 grains of ammonium iodid and 2 grains of cadmium bromid.

Some operators use a little chlorid of calcium in the collodion. The writer can not see any advantage in its introduction, while it adds to the complication when purifying the silver bath. A 45-grain-to-the-ounce silver bath is recommended with this collodion.

The preparation and care of the silver bath, with instructions for its purification when contaminated with foreign matter, is described in the chapter on Photolithography.

GETTING IT IN THE NEGATIVE.

In the early days of half-tone negative-making, before staging, reetching and the skill of the finisher in bringing the flat-etched half-tone to reproduce the copy came into use, it was necessary for the half-tone photographer to get all the gradations in the negative. He had no tables of screen distances and diaphragm apertures or automatic appliances to assist him. He did work so well that it is a source of wonderment to present-day processworkers when they run across half-tones in the magazines and publications of 1892-93. He reached correct screen distance and the proper diaphragms by observation of the effects of the screen upon the ground glass, and this the beginner at half-tone negative-making is recommended to do.

AS TO THE DIAPHRAGMS.

The half-tone photographer should have had previous training in line negative-making and have learned the proper

use of diaphragms and the correct periods of time for exposure to get sharp and perfect negatives of any subject copied.

The principles of half-tone negative-making are similar to line negative-making as far as getting a negative of the copy sharp to the corners — one difference being that the interference of the screen increases the exposure at least four times what it would be without the screen. There is a common mistake that the screen sharpens the image upon the ground glass. It is the diaphragm in the lens that produces the sharpness of image. If the diaphragm used in the lens when making a half-tone negative will not produce a crisp image without the screen, then the introduction of the screen will lessen rather than improve the definition.

CHOOSING THE NORMAL DIAPHRAGM.

Hence, the first thing to consider in the choice of a diaphragm for half-tone negative-making is whether it will cut the image sharp to the corners of the plate. For the beginner it is recommended that he use three round diaphragms, the iris diaphragms in the lens being suitable. Let the copy chosen to experiment with be a photograph neither too flat nor too contrasty, but with the proper gradations of light and shade.

The required size of the half-tone and the focus of the image can be had on the ground glass without a diaphragm and without the half-tone screen, if the camera is one in which the screen can be swung out of the way or is carried in the plateholder. Should the screen be in front of the ground glass it must be separated from the ground glass as far as possible until the proper size and focus of the image are obtained.

TO FIND THE SCREEN DISTANCE.

When the largest round diaphragm that can be used and obtain a sharp image is selected insert it in the lens. Then move the screen close to the ground glass by the mechanism for that purpose. The cross-bars on the screen will be found to throw sharp shadows on the ground glass

HALF-TONE OF 1868.
By General Frederick W. Von Egloffstein.
Reproduction by F. A. Ringler Company, New York.

with square spots of light. Now while slowly moving the screen away from the ground glass study, with a focusing glass or magnifying eyepiece, the screen effects in the high lights of the copy. When a "chess-board" formation of light squares and opaque squares is seen, just touching each other at diagonal corners, then fix the screen at that distance from the ground glass, for this is the effect desired in the middle tones of the finished print, and the diaphragm with which it is formed is called the "normal stop."

THE HIGH-LIGHT STOP.

The largest of the three diaphragms used is called the "closing-up" or "high-light stop." This is selected by leaving the screen at the distance chosen, through the use of the normal stop, and by using larger diaphragms watch the effect on the ground glass. It will be noticed that as the aperture in the diaphragm increases in size the screen shadows on the ground glass become less obvious until they disappear altogether. When the screen shadows become merely black dots on the ground glass then the aperture in the diaphragm is correct for the high-light exposure and this diaphragm will be termed the high-light stop.

SELECTING THE SHADOW STOP.

The diaphragm used to give the small white dots in the shadows of the finished proof is called the "shadow stop." This can be one-half or less the diameter of the normal stop. The effect of this stop will be understood by inserting it in the lens and covering the copy with a sheet of white paper; then observe the small dots of light formed on the ground glass. As the aperture of this diaphragm is enlarged the light dots increase in size on the ground glass, and two points must be remembered in selecting this shadow stop: that the smaller it is, the longer the exposure required and the less "cutting" will be necessary on the negative film later to reduce the dots in size; while if a larger shadow stop is used and the dots develop too large, they can be reduced by the cutting solution.

Now that the screen distance and diaphragms are selected by observation the correct exposure for each diaphragm must be determined, and that can be done by experiment. Here is a plan for obtaining at one trial most information regarding the proper periods of exposure. It is done by making three exposures on a single sensitive plate, the subject being a wash-drawing or a good photograph.

Let us suppose the copy is strongly illuminated and the reduction is one-half, the normal diaphragm required to make the copy sharp to the corners is ¼ inch in diameter, the high-light stop is ½ inch, and the shadow stop is ⅛ inch. We will make out a tentative table of trial exposures like this:

A. Shadow stop ..⅛ inch diameter..Exposure 4 minutes
B. Normal stop ...¼ inch diameter..Exposure 2 minutes
C. High-light stop.½ inch diameter..Exposure ½ minute

THREE TRIAL EXPOSURES.

The three exposures on the same negative are made in this way: After placing the plateholder containing the sensitive plate in the camera, draw the slide so as to uncover for exposure one-third of the sensitive plate; this we will call exposure A. Then by drawing the slide again expose two-thirds of the plate for exposure B, and finally expose the full plate for exposure C.

Before making exposure A, the shadow stop has been inserted in the lens; then remove the cap from the lens for four minutes. For exposure B the normal stop is inserted in the lens and the cap is withdrawn for two minutes. For exposure C the high-light stop is inserted in the lens and the latter uncapped for one-half minute.

Development of this plate will exhibit on section C the effect of the high-light stop alone; section B will show the effect of the high-light stop and the normal stop; and section A will demonstrate the result of the exposures of all three stops. To study properly the effect of these trial exposures the negative, after fixing in cyanid of potassium, should first

A HIGH-LIGHT HALF-TONE OF 1880.
By S. H. Horgan.

be intensified with copper and silver as explained in the chapter on line negative-making.

After intensification, if the shadow dots are not intense enough in section A, the checker-board pattern not strong enough in the middle tones of section B, or even in section A, and should the high lights not show a tendency to close up in section C and be almost entirely closed in section A, then the exposures on all three stops have not been long enough. Should one or two of the exposures be sufficient, this trial negative will show it. If on the other hand the exposures seem to have been carried too far, then try the effect of cutting the negative as will be explained later.

KEEP A RECORD OF EXPOSURES.

Just here the reader is recommended to keep a record of each negative with all the factors that entered into the making of it. There are exposure books for dry-plate photographers' use that can be made to answer the purpose admirably. First the negative is numbered, then is recorded the title and kind of copy, the strength and kind of light and its distance from the copy, the reduction or enlargement, screen pitch, distance from the sensitive plate, number and kinds of diaphragms used and the various periods of exposure, together with the features of the intensification and the reduction or "cutting" of the negative. When it is possible to secure proofs of the engravings before finishing, they can be kept in a scrap-book numbered, as are the negatives, so that at any time there is a "make-over" the method employed in making the first negative may be consulted and suggestions for improvement studied out. In this way one has always before him "past performances," for experience is, after all, the best teacher.

SCREEN DISTANCE AND EXPOSURE AT ONE TRIAL.

Another way suggested to secure several trial exposures on a single plate is this: The same procedure may be observed as described for the previous trial negative, as far

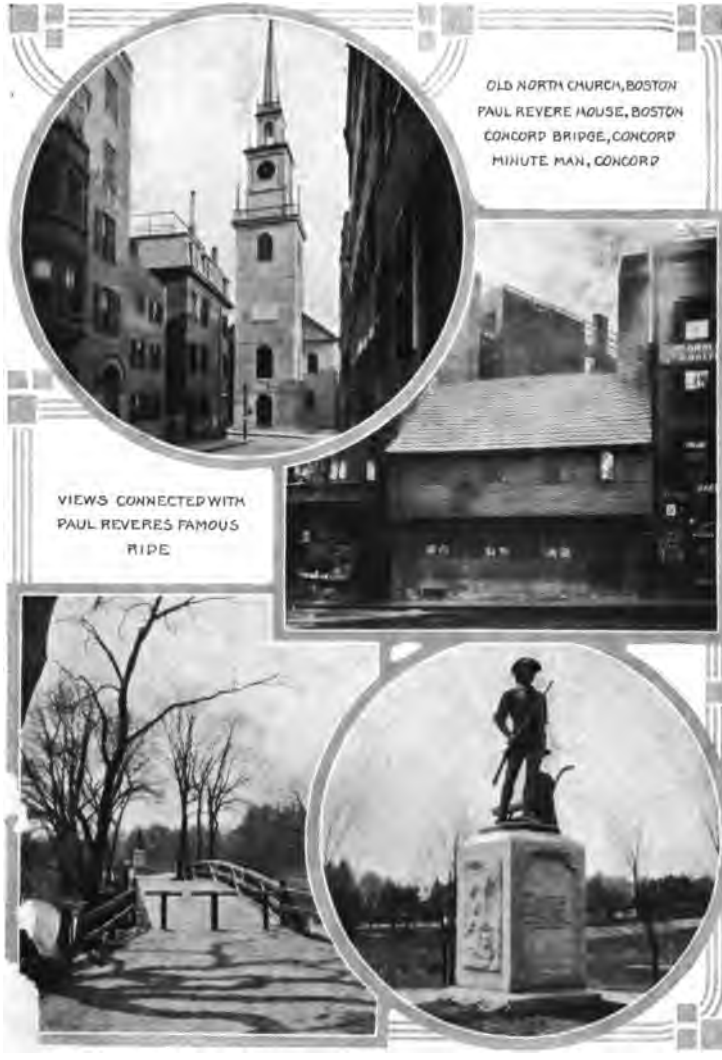
as use of the diaphragms and the three different exposures, except that when putting the sensitive plate in the holder, if it is one that also carries the half-tone screen, rest the lower edge of the sensitized plate in its proper place but allow the upper edge of the plate to rest against the half-tone screen, the latter being pushed away from the sensitized plate as far as possible. If the sensitive plate is a wet plate it is necessary to have a strip of blotter between the upper edge of the plate and the screen to keep them from touching. The wet plate has of course been properly drained and its upper edge wiped dry before putting in the holder. This will give a wedge-shaped screen distance, beginning with less than one-sixteenth of an inch at the top of the negative, and, say, six-sixteenths of an inch at the bottom. On developing this plate and fixing in cyanid of potassium there will be found a line somewhere between the top and bottom where the screen distance is correct. To find this proper distance it will be necessary only to indicate the line of correct distance, put the negative back in its original position in the plateholder and measure the space between the correct line of distance and the half-tone screen to find the correct screen distance.

REDUCING, OR "CUTTING," THE NEGATIVE.

The semiopaque fringe seen with a magnifying glass around the edge of the dots in the half-tone negative, after intensification, must be dissolved away so as to leave each dot sharp and equally intense over its whole area. This operation is called "cutting," and the cutting solution can be made from two stock solutions as follows:

A.	Water	10 ounces
	Potassium iodid	1 ounce
	Iodin, crystals	½ ounce
B.	Water	10 ounces
	Potassium cyanid	½ ounce

For use, take ½ ounce of the iodin solution A in 10 ounces of water and add some of the cyanid solution B slowly to the wine-colored iodin solution until it becomes just transparent, and you have the "cutting solution."



A COMBINATION PLATE.
Folsom & Sunergren Co., Boston.

Flow this cutting solution over the whole negative image in one sweep, as is done with developer; allow it to flow back and forth over the negative a few times; drain it back into its bottle, and watch the effect on the fringe on the high-light apertures in the negative and the shadow dots, the latter particularly.

It is advisable to do this work over a sink with a tap of water within easy reach so that, if necessary, a stream of water may be turned on instantly over the half-tone image to stop the action of this reducing solution. Should the solution act too quickly it must be diluted with water, for it is necessary that it dissolve away the fringe from around the dots very slowly.

Of course local reduction can be had by pouring the solution on the part to be reduced, allowing it to flow back into its bottle, and then rinsing the negative at once with water. Repeat these operations until the local reduction is had.

After the negative image is reduced or " cut " sufficiently it is blackened by flowing over it

Water	10 ounces
Sodium sulphid	1 ounce

Should the half-tone negative not have density enough it can be treated once more with the copper and silver intensifier, followed with the cutting solution and sodium sulphid, taking care to wash the negative well between each treatment.

ANOTHER NEGATIVE REDUCTION METHOD.

By using the A and B components of the cutting solution heretofore mentioned separately, the reduction of the dots may be brought about in a more satisfactory manner for the reason that the operation can be more easily watched.

After fixing the negative in cyanid and intensification with copper and silver as described, take one ounce of the A solution in ten ounces of water and flow the half-tone negative with it. The film will gradually become a beautiful cream color. When this color has penetrated through to the back of the film, as seen through the glass support, the nega-

tive may be rinsed under the tap and flowed with the cyanid of potassium solution B diluted also ten times with water. As the transparent half-tone dots in the negative will, by reflected light, appear black against a light cream ground, the action of the cutting solution can be studied readily and stopped, when it has proceeded far enough, by washing the negative well under the tap; after which the negative film is blackened with the sodium sulphid solution before mentioned.

HALF-TONE NEGATIVE PRINCIPLES.

We have been considering the making of a half-tone negative from perfect copy. As the greater portion of the copy supplied for reproduction in half-tone is anything but normal copy, being either too flat or too contrasty, too light or too dark, a few of the principles governing the treatment of abnormal copy will be stated here.

To obtain a contrasty half-tone from flat copy, increase the screen distance or enlarge the high-light stop. Be careful not to overtime the negative, but carry the development as far as possible and intensify several times if necessary.

From overcontrasty copy a negative with less contrast may be had by reducing the screen distance or the size of the high-light stop; overexpose, but be careful not to overdevelop. After intensification, local cutting of the high lights will reduce the contrast still further if found necessary.

For light copy overexposure must be avoided, while with dark copy plenty of time should be allowed in the exposure.

Red-toned photographs on glossy printing-out paper make the best copy but require long exposure.

Glossy black prints of the Velox order make the next best copy, though they also require long exposure.

FLASHING SHOULD BE AVOIDED.

Flashing is a practice resorted to in the case of copy with extremely dark shadows that would not reflect much light. It is done by covering up the copy with a sheet of white paper and exposing the sensitive plate to it while a very small diaphragm is inserted in the lens. The exposure is for about

one-twenty-fifth the total exposure with the other diaphragms. This gives a small dot in the deep shadows, produced artificially, and the practice is to be discouraged except in the case of newspaper half-tones when the small dots in the shadows of the plate assist in the stereotyping and printing.

Gray matt bromid or platinotype prints require less exposure, and are most frequently to be treated as flat copy.

POINTS IN HALF-TONE NEGATIVE-MAKING.

Exposure is the most important factor of all in making half-tone negatives. Underexposure can rarely be corrected by intensification. Overexposure can most often be overcome by use of the cutting solution.

As the camera bellows is extended the screen distance should increase. Long-focus lenses require much screen distance.

Short-focus lenses require short-screen distance, for the nearer the lens is to the sensitive plate the shorter must be the screen distance.

A fixed screen distance can be kept with each screen used for all reductions and enlargements, the only change being made in the size of the stops, these being increased in size with enlargements and reduced with reductions.

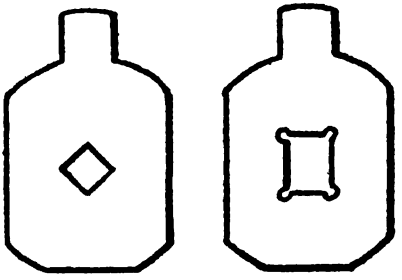
The coarser the screen used, the larger the diaphragms; the finer the screen, the smaller the diaphragms.

The screen opening is in the same proportion to the screen distance as the aperture in the diaphragm is to the distance between the diaphragm and the sensitive plate, so that having any three of the factors it is easy to calculate the fourth.

The farther away the screen can be kept from the sensitive plate and the smaller the normal stop used, the more detail will be retained in the half-tone reproduction.

The closer the screen to the sensitive plate, the more "screeny" the result; while if the screen is removed too far from the sensitive plate there is danger of the high-light dots being closed up.

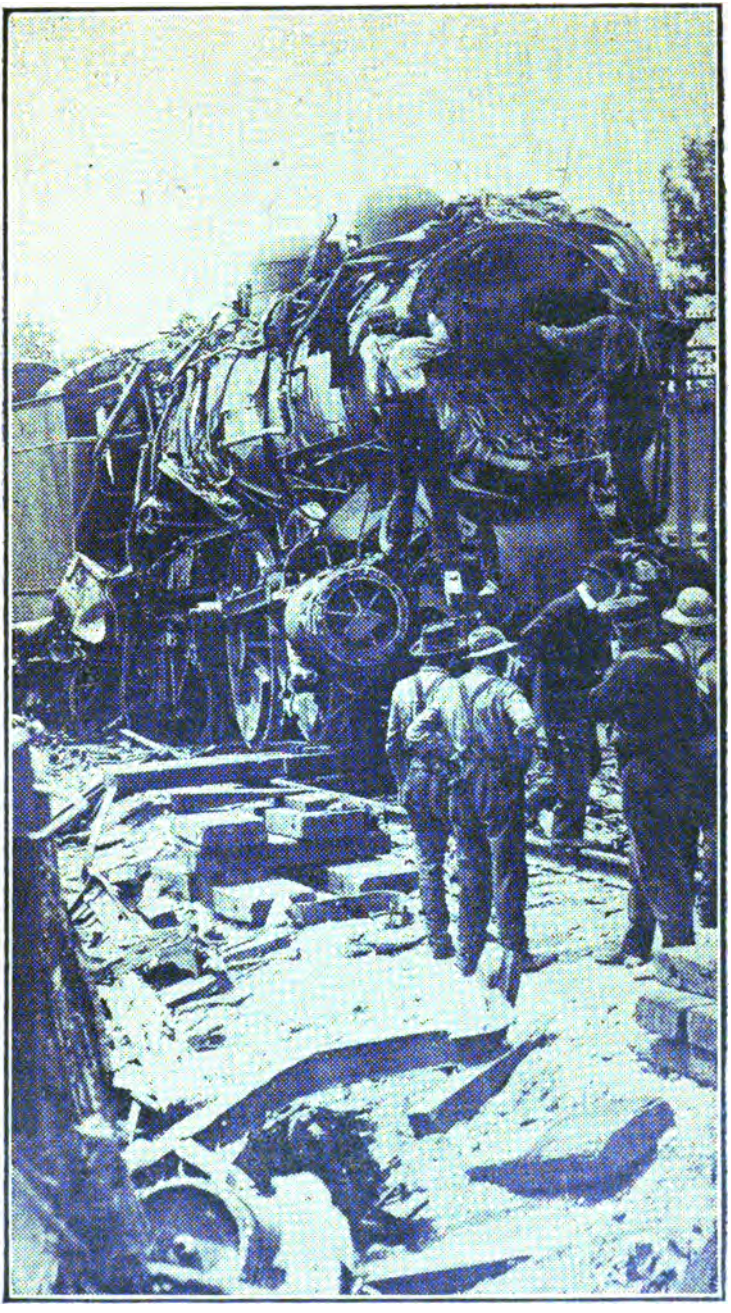
The shape of the half-tone dot is governed to a great extent by the shape of the aperture in the diaphragm, as the half-tone dot is largely an image of the diaphragm aperture. The half-tone photographer can take advantage of this. For instance, if he wants a half-tone negative in single lines from a cross-line screen, he can cut from bristol-board a diaphragm with a slit opening at an angle of forty-five degrees to its sides, which will give a half-tone negative in single lines.



"HORGAN STOPS."

In 1897 the writer devised two stops for making newspaper half-tone negatives, in which the aim was chiefly great contrast. The smaller one, for getting the shadow dots, was a square stop set diagonally, and the larger one — for closing up the high lights quickly — was a large square stop with the corners extended. They have gone into general use and have been given the writer's name. They are referred to here for the reason that these stops have been redrawn by several artists, when copied into French, German and other publications. Then they have been recopied back into English publications in such distorted shapes that the author can scarcely recognize them. Further, and what is much worse, they are recommended for all half-tone purposes when they were only intended to produce contrasty negatives, for which they will be found to be admirably adapted.

Every conceivable shape of diaphragm aperture has been tried for normal half-tone negative-making and the expe-



AFTER COLLIDING WITH THE OVERLAND EXPRESS

NEWSPAPER HALF TONE BY AMERICAN PRESS ASSOCIATION

rience gained from their use is that the round, square, and square with extended corner stops fulfil all requirements. Still half-tone operators will continue to construct their favorite shaped stops, and from the wonderful results they alone obtain from their use they would seem to be justified.

HALF-TONE DEVELOPMENT.

The feature to be observed in half-tone development is that the developing solution be flowed over the exposed plate so as to cover it in one sweep. Stoppage of the flow of developer is liable to leave a line that can not afterward be eliminated.

Should the sensitive plate, from long exposure, become too dry, it can be dipped once more in the silver bath. This supplies the surface with the free silver which, combining with the iron of the developer, forms the intense image desired. Drying of the plate from long exposure may be prevented by placing a sheet of wet, red, or other color than white, blotter behind the sensitive plate in the plateholder during exposure.

When fixing the plate with cyanid of potassium solution care must be taken that it is not so strong that it will dissolve away the delicately graded fringe that surrounds the dots, for this fringe is later to be intensified and brings about the joining of the high-light dots that is so necessary.

POINTS OF INTENSIFICATION.

The half-tone negative must be washed well between intensifying operations to prevent stain. A tendency to discoloration of the transparent parts of the film can be removed with a weak solution of nitric or hydrochloric acid.

No rules can be laid down that will describe precisely the intensification and "cutting" operations, for etchers are not agreed as to what constitutes the best half-tone negative. Some etchers insist on what they call a "fat" high-light dot in the print on metal so as to allow for its reduction during etching. The higher-skilled etcher can use a negative that is not so flat but has more of the gradations of the original

copy. One point etchers do agree upon, and that is that the finer the needle-point dots in the deepest shadows the better, for the tendency is to enlarge these dots as the etching proceeds and thus flatten the result.

HALF-TONE ENAMEL.

The sharp smooth-edged character of the relief half-tone dots on copper is due to the acid resist used, which is called "enamel" because — like the enamel on a watch-dial, the enamel on leather, or true enamels — it is applied to the metal plate while in solution and by the application of heat dries with a hard, smooth, glossy surface which is a splendid resistant of the chlorid of iron used to dissolve away the copper.

The enamel used on a metal plate, usually copper, is composed of a fish-glue, with the addition of albumen or other colloid, and made sensitive to light with ammonium bichromate and sometimes chromic acid. It is a simple mixture which, when intelligently handled, will give least trouble of all the processworker's solutions.

Here is a formula that has been found reliable, during years of use, under all kinds of conditions:

Water	5 ounces
Le Page's glue	1½ ounces
Albumen, from a fresh egg	1 ounce
Ammonium bichromate	100 grains
Aqua ammonia (about)	12 drops

The clarified glue varies in the proportion of water it contains. It, as well as the enamel, should be kept in a cool place and used always at the same temperature, for it will be found to be thicker as the temperature lowers and thinner as the temperature rises.

Albumen is not necessary to form an enamel. It increases the sensitiveness, though, and aids in the development of a cleaner and sharper print. Enamel containing albumen will work best when one or two days old, but will spoil within a week if not kept on ice.

A thick coating should have proportionately less bichro-

MEZZOGRAPH SCREEN.

The first photoengraver, Joseph Nicéphore Niépce.
The Cincinnati Process Engraving Company, Cincinnati.

mate than a thin one, for the reason that the enamel must be acted upon by light through to the copper in order that it may not wash away in development. The orange color of the enamel is a strong color filter, to prevent light from penetrating and hardening the enamel in contact with the copper, and this is just where the enamel should be most impervious to water. The orange-colored enamel coating is specially resistant to the blue-violet rays of an enclosed arc electric light, so that where such lamps are used the enamel coating should be thin.

The addition of ammonia renders the solution more light-absorbent by changing its color from an orange to a pale yellow. Also, by neutralizing the solution, it preserves it in working condition longer. Where chromic acid is used, ammonia changes some of the chromic acid to a chromate of ammonia.

PREPARING THE COPPER FOR ENAMEL.

That the enamel acid resist may stick during etching depends to a great extent on the preparation of the copper surface. All trace of oil or grease used in the machine grinding and polishing of the copper must be removed by warming the metal and brushing over its surface some clean caustic potash in solution, or by scrubbing the surface with whiting moistened with water containing a little caustic potash. It is customary to go over the surface of the copper with willow charcoal to remove the burnished surface and give the metal a slight tooth to hold the enamel better. This polishing with charcoal should be done with clean water and in the direction of the machine polish. Wash off with a wad of clean cotton or a sponge any adhering charcoal or other cleaning powder, and then the cleaned copper is ready for

COATING WITH ENAMEL.

After mixing the enamel it is filtered a couple of times through a pledget of filtering cotton in the neck of a glass funnel, taking care that no bubbles are formed in the filtered solution.

While the copper plate is still wet with clean water it is flowed with the enamel and the first coating allowed to flow off in the sink. The second coating may also go to waste. The third or fourth coating, providing it contains no dirt specks or air bubbles, should be retained while the plate is quickly fastened in the whirler and revolved at such speed as is found by experiment to give the proper thickness of coating. This whirling is usually done in a circular drum or tank to catch the surplus enamel that flies from the edges of the plate. At the bottom of this drum is a circle of low-burning gas jets, or a gas stove covered with an iron plate, from which the heat arises to dry the enamel coating.

PRINTING AND DEVELOPING ENAMEL.

When bringing the negative and enamel-coated copper together, care must be taken that they are of the same temperature or a sweat may be formed upon the enamel. The printing-frame is one made for the purpose. The proper period of exposure can be found only by trial. With a properly intensified negative there is not much danger of over-exposure.

When the exposed copper plate is removed from the frame it is laid in a tray of clean water to permit the glue unhardened by light to soften. This will require a minute or more, when the plate is placed under the tap and a strong jet of water allowed to fall upon it, which washes away the softened enamel. There is in a good light, sufficient difference between the brown shade of the light-hardened glue and the pink of the bared copper to tell when the image is developed clean. The best operators do not dye the enamel to determine when the development is finished.

Should a dye be considered necessary, methyl violet is the one most commonly used. A weak solution of it is poured on and off the developed image, which it quickly stains. The writer has found an anilin dye called " cotton blue " to give a better color contrast to the copper, and when enamel stained with it is flowed over with a weak solution of alum it changes

in color to a most brilliant blue. All anilin stains disappear as the enamel is being burned in.

Overexposure, shown by slight traces of glue in the shadow dots, can be overcome by pouring on these dots slightly warmed water, and spots requiring further development can be "tickled" clear by drawing over them wet cotton. Development being completed, the enamel is dried, in sunlight when possible.

BURNING THE ENAMEL.

Or, the copper plate is gripped with a wide-nosed pliers and moved over a proper gas stove until the moisture is slowly evaporated out of the enamel image; then the heat is increased and the changing colors of the enamel watched so that by moving the plate it will be heated alike over its whole surface. As the heat of the copper increases the color of the enamel changes from a yellow to a brown, gradually becoming darker until it reaches a deep chocolate, which indicates that the enamel is sufficiently carbonized. A thin enamel coating, which is best for fine work, will not burn to as dark a color as a thick coating. Enamel containing chromic acid can be burned almost to a black. When the enamel is dark enough the exposed copper usually changes in part to a silvery hue. The heated copper is now stood against a wall to allow air to circulate around the hot copper plate, and cool it evenly. Under no circumstances plunge it in water or lay it on a cold slab, as sudden cooling destroys the temper of the copper.

TO REMOVE SCUM.

When the developed plate is first put into the etching solution it will be found that there are some portions, particularly in the fine shadow dots, that are not attacked by the iron solution; this is due to a slight veil of enamel covering the copper in these parts, which is termed "scum." And so common is it that most etchers apply an agent for removing any possibility of scum before they attempt to etch the plate.

Among the various suggestions for scum removal the following solution will be found efficient:

Water	20 ounces
Table salt	4 ounces
Hydrochloric acid	2 ounces

Another solution used is similar to the above except that acetic acid is substituted for the hydrochloric acid. Either solution is applied and with a brush scrubbed vigorously over the enamel image until the copper shows bright everywhere. The plate is rinsed quickly under the tap and plunged into the iron etching fluid.

HALF-TONE ETCHING.

Copper etching is a much simpler operation than three-bite zinc etching after one has confidence. Most failures occur from timidity, for the reason that with a vigorous, quick etching with chlorid of iron there is little danger of the acid-resisting enamel protection being injured, while the use of a weak etching solution and much washing with water will soften the enamel. It is for this reason that the quick action of an etching machine gives a more satisfactory result than can usually be had in the slowly rocked etching tub.

Chlorid of iron is the most reliable etching fluid. It can be purchased in a neutral solution at a strength of about 40° B., or, the iron chlorid (ferric chlorid) can be purchased in lumps and dissolved in hot water until, when cool, it tests 40° B. From 37° to 40° B. will be found the best strength for etching enamel protected copper. A mixture of old and new etching bath in the proportion of equal parts of each will etch smoother than an entirely fresh solution of chlorid of iron. A warm iron solution will etch much faster than a cold one.

If an etching machine is not available, then " still " etching is recommended. This is done by turning the plate face down in the chlorid of iron solution, avoiding air bubbles, the corners of the plate resting on supports which keep it as far from the bottom of the tray as possible. The principle of

this method of etching is that the iron solution dissolves the copper and both fall to the bottom of the tray while fresh etching fluid rushes in to take their places. It dispenses with brushing to clear the etched parts of oxid, and there is not so much danger of undercutting as when the etching tub is rocked and the iron solution is dashed against the sides of the dots.

When a copper plate is etched in a rocking-tub it should be turned occasionally and brushed as little as possible, for when brushing out the oxid that adheres to the bottom of the fine-shadow dots there is a tendency to open up these intaglio dots and gray the result. As the etching approaches the proper depth the fine isolated dots in the extreme high lights are usually undercut, so that the enamel protection is held only in the center like an umbrella. This is a warning to stop. On examining the dots with a magnifier do not wash the iron solution from the plate; blow it from the spot to be examined. When the etching is completed, water can be applied to the enamel for the first time since the scum was removed. After washing, the adhering water is absorbed by dabbing the surface with a dampened piece of chamois-skin and the plate is dried by heat.

The enamel is then gone over with a dry nail-brush, which removes the umbrella-shaped fringes from the dots; the etching is rubbed full of magnesia, which fills in the etched portions and shows the actual state of the etching.

HALF-TONE FINISHING OR REETCHING.

Sometimes copper half-tones are only flat-etched in the tub or machine. That is they are etched until the shadows are right in tone, the lighter tones and high lights being reduced to their proper fineness by the engraver called a finisher. His method is to protect with asphalt or shellac varnish the shadows, or areas sufficiently etched, and then, with a bamboo-handled Chinese marking brush, paint chlorid of iron solution on the high lights, gradually spreading it over the darker tones, until the dots in those portions, so covered with iron, are reduced to print light enough. The

iron solution is absorbed from the etched surface with pieces of blotter. This work requires great skill and artistic judgment on the part of the finisher, who usually is one who has been trained as a wood engraver. He has the copy from which the half-tone negative was made before him as he proceeds with the reetching. On the manner with which he usually improves on the copy depends the quality of the half-tones produced and the reputation of the house by which he is employed.

VIGNETTING.

Vignetting is usually done by the engraver-finisher, who first fills in the half-tone with magnesia and indicates with a pencil outline on it where the dots should fade away so as to be no longer seen. Outside of this line he covers the dots with the asphalt or shellac varnish. When the varnish is dry he proceeds to paint chlorid of iron solution on the dots nearest the edge of the varnish, gradually encroaching on the image. When the iron solution has exhausted itself it is absorbed with a piece of blotter and fresh iron solution painted on as before. These operations are repeated until the enamel begins to disappear from the pin-pointed dots at the extreme edges, when the plate is washed off. To remove the stain the acid and salt solution, used for scum removal, will, when brushed over it, brighten up the whole plate. After washing and drying, the plate is turned over to the router.

After routing, the outer edges of the vignetted plate may be chamfered on the under side so as to lower the printing surface when blocked. This requires but a very slight bevel from the outer edge to about a quarter inch deep on the under side of the vignetted plate.

PROVING, BEVELING, ROUTING, BLOCKING.

Proving is done before the plate is mounted, for the reason that it can be underlaid and also to prevent the wooden blocks from being soiled. This is the work of a pressman and need not be described here. Neither does the

DUOGRAPH.

From a daguerreotype of Louis J. M. Daguerre, after whom the first photographic process is named.
Plates by the Electro-Light Engraving Co., New York.

mechanical operations of routing, beveling and blocking require explanation in this book devoted only to photo-mechanical processwork.

HALF-TONE ENGRAVERS SHOULD KNOW

MR. IVES' HALF-TONE ENAMEL FORMULA.

Mr. Ives says this is his enamel formula for the ideal half-tone negative, which negative he describes as a vigorous one, where the gradation of line and dot is complete, and there are no dots to print out in the shadows, while the dots in the high lights are sufficiently fine and sharp without any of the whittling down, which may be accomplished by fine etching: Some will wonder how I would, in the etching process, keep such fine dots in the shadows, which would be printed out by the methods usually employed. Or, preserve such fine dots in the lights, which would be etched out in the ordinary course of procedure. To accomplish this, I prefer a fish-glue enamel without albumen, for copper etching, as follows:

Le Page's glue	5 ounces
Bichromate of potash	88 grains
Chromic acid (pure)	40 grains
Aqua ammonia (strong)	1¾ drams
Water	12 ounces

Dissolve the bichromate in ten ounces of water, then add the glue and thoroughly mix. Then the chromic acid, dissolved in two ounces of water, should be added drop by drop, while constantly stirring, and finally the ammonia. This solution keeps better than one containing albumen, and though it sometimes goes wrong in a few days, Mr. Ives says he has used it with perfect success when five months old.

HALF-TONE IN HOT WEATHER.

To keep the sensitized wet plate moist in hot weather during long exposures is a problem. Here are a few rules which, if followed, will prevent the plate drying: The

ground glass should always be kept in the camera when the latter is not in use. In the morning the interior of the camera box should be wiped out with a large damp sponge such as is used in washing carriages. The plateholder should be treated in the same way. Place a few folds of wet cloth on a piece of galvanized wire netting inside the camera box.

Have the darkroom floor, tables and shelves scrubbed out once a week. After the day's work sweep out the darkroom thoroughly and dust it with a damp cloth or sponge in the morning. After sensitizing the plate, allow it to drain well, wipe all silver solution from the back and particularly from the top edge of the glass plate. When the sensitive plate is in the holder, place against the back of the glass plate a piece of eighty-pound blotter an inch or so smaller all around the plate. This blotter should be wet but not dripping. The blotter should not be white unless a piece of black cloth or paper is placed between it and the back of the sensitive plate, thus preventing reflection of white light on the sensitive film.

INVENTOR OF THE ENAMEL ACID RESIST

Charles E. Purton, working in Philadelphia about 1883, is said to be the first one to use gum arabic and fish glue to coat a copper plate with and afterward carbonize the film so as to make it acid resistant.

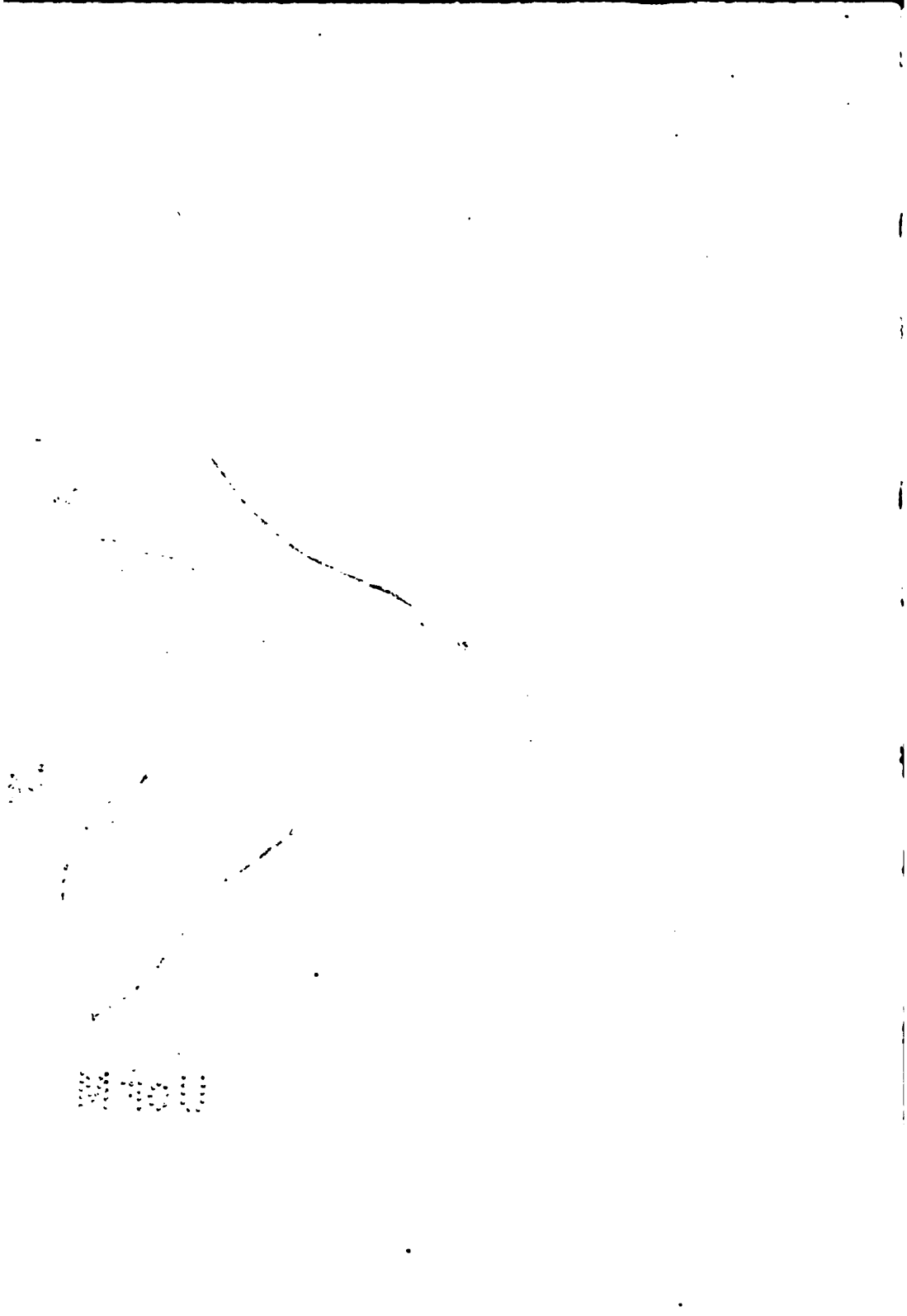
In the *Photographic News* of November 4, 1881, Major-General Waterhouse described the Garnier process, in which a copper plate was coated with a solution of two grams of sugar and one gram of bichromate of ammonia in fourteen grams of water. This coating was dried and printed under a positive, and dusted with an alkalin powder, when the image showed plainly. (This was the origin of the dry-enamel process.) After which the copper was heated over a flame until it showed iridescent colors. The sugary coating thus becomes hard in the exposed parts, but under the powder it is broken, powdery and permeable to acids. It was then etched in perchlorid of iron.

FIG. 2.— THREE-COLOR REPRODUCTION, RED IMPRESSION.
Negative made through a green filter.

FIG 3.— THREE-COLOR REPRODUCTION, BLUE IMPRESSION.
Negative made through an orange filter.

Fig. 4. — Three-color Reproduction, Yellow-red Impression.

FIG. 5.— THREE-COLOR REPRODUCTION, YELLOW-RED-BLUE IMPRESSION.



THREE-COLOR PROCESSWORK,

AND ALSO

THE MAKING OF COLOR BLOCKS FOR FOUR PRINTINGS.

Before undertaking color processwork of any kind it is advisable to have one's eyes examined by a specialist to learn if there is any defect in color perception. Color-blindness is more common than is generally known, and it is only of recent years that much attention has been given to it. Examination of students' eyes in one of the largest art schools in the United States showed that over sixty per cent lacked normal color-vision. More recent statistics prove that women have far better color discrimination than men.

Some eyes lack entirely any appreciation of the sensation of red, others fail to distinguish green, while a few are blind to the violet sensation. There are degrees in the defectiveness of eyes to the color sensations, perfect color-vision being rare. The nearer perfect color-vision is, the better will its possessor succeed at color processwork of any kind.

THE FATHERS OF THREE-COLOR PROCESSES.

The idea of the three-color process may be said to have originated with Clerk Maxwell, who, in 1855, while an undergraduate at Trinity College, England, and but twenty-four years of age, wrote this: "Here we have a complete system of recording color by photography, but the preparation equally sensitive to rays of every color has not yet been found."

In 1859, Louis Ducos du Hauron began experiments in three-color work. By 1869 he seems to have mastered the theory of the subject, for he published a book, entitled "Les Couleurs en Photographie. Solution du Probleme."

Henry Collen in England and Baron Ransonnet in Vienna proposed in 1865 to make three negatives from a colored subject through red, yellow and blue glasses.

Dr. H. W. Vogel made three-color work possible by discovering color-sensitizers for photographic plates and setting forth, in 1873, this principle: the color used in dyeing the sensitive plate must be the same color as the pigment used in printing the block made from the plate.

Nothing came of Dr. Vogel's discovery until a lithographer named Ulrich, in Berlin, attempted to put Dr. Vogel's theory into practice. He found by lithography it was necessary to introduce a fourth printing, either gray or black, to get strength in the shadows. He showed some of his results at the German Exhibition in London in 1891 and received a medal.

Mr. Fred E. Ives had exhibited a three-color half-tone print at the Novelties Exhibition, Philadelphia, in 1885, but it is to Mr. William Kurtz we owe the practical application of all the three-color theories that had gone before, though he lost his private fortune through his experiments.

The *Engraver and Printer,* of Boston, in March, 1893, published a frontispiece with this title: "Photography in Colors. Taken from Nature by W. Kurtz, Madison Square, New York. Printed in Three Colors on the Steam Press." This was a fruit-piece printed from three single-line blocks and proved to the whole printing world that reproductions of colors by photography into three half-tone blocks to be printed in colored inks had arrived.

THE THEORY OF THE THREE-COLOR PROCESS.

All three-color processwork is based on the theory that there are but three primary colors, and that all the other colors or hues are mixtures of these three in varying proportions.

Tints in three-color block printing are obtained by allowing exposure, in varying degrees, of the white surface on which the three colors are printed. Shades are the result of superimposing the three-colored inks in dots on and between each other, until black is reached by printing the three colors solidly over each other.

For clearness sake the three colors used in the printing-inks will be called yellow, red, and blue, according to Prang's standard colors.

Let it be remembered that in making a negative of a black-and-white subject, for ordinary photoengraving and printing in black ink, the black in the copy does not affect the sensitive plate; it is represented by the transparent part of the negative. It is only the white and the lighter shades that form the deposit in the negative, and these are not printed in the printing-press. It is the same in three-color record negative-making. The color that is recorded on a color-record negative is the one that is cut off by the filter and not allowed to reach the sensitive plate, or, the color for which the plate is insensitive.

The theory is that in making the negative for the yellow printing-block the yellow in the copy should not affect the sensitive plate, but should be the transparent part of the negative and is therefore the yellow color-record negative. In making the negative for the red printing-block the red in the copy should not affect the sensitive plate but should be the transparent part of the negative. In making the negative for the blue printing-block the blue in the copy should be represented by transparency in the negative.

The negatives in three-color work have no color in themselves, but record the amount and gradations of each of the three primary colors found in that which is photographed. Hence they are properly termed color-record negatives and sometimes color-separation negatives.

THEORETICAL SENSITIVE PLATES FOR THREE-COLOR WORK.

To make three-color record negatives the yellow negative should be made on a plate that is sensitive to red and blue, and insensitive to yellow; the red negative should be made on a sensitive plate that is sensitive to yellow and blue, and insensitive to red; while the blue negative should be made on a plate that is sensitive to red and yellow, and insensitive to blue. Or, the color-record negatives should

be made on panchromatic plates, sensitive to all colors, by filtering out with color screens the colors to be recorded.

THE THEORY OF THE COLOR FILTERS OR SCREENS.

To aid in carrying out this theory, transparent colored screens or filters are used. These are transparent colored mediums through which the rays of light pass in going from the copy to the sensitive plates. In making the yellow negative, a purple-colored filter should be used to shut out the yellow rays and allow only the red and blue rays to pass through; for the red negative, a green-colored filter should shut out the red rays and permit the yellow and blue rays to pass; and for the blue negative, an orange-colored filter should shut out the blue rays and permit the passage of the yellow and red rays of light from the copy. So much for the theory.

PRACTICE VERSUS THEORY IN THREE-COLOR PHOTOGRAPHY.

In practice it will be found that neither color filters, sensitive plates, nor three-color inks are available to carry on three-color block-making precisely as laid down theoretically in the previous paragraphs. Why this is so is too long a story to be told here. By numerous compromises and skilful manipulation, however, these difficulties are in a measure overcome, so that in practice three-color blocks can be produced which are quite satisfactory.

Some establishments find that for some subjects it is better to add a fourth plate to be printed in gray, or a warm or cold black. How this fourth plate is made will be told when the use of color screens or filters is described.

THE LIGHT.

Daylight in or near large cities and in changeable weather is too variable to furnish the best illumination for three-color negative-making. The color of the light from a clear sky, it will be understood, is bluer than from a clouded sky. So also is the light from the sun yellower as it sinks in the west. These variations in the color of the light alter the colors in the copy, besides making it almost

THREE-COLOR HALF-TONE.

The Zeese-Wilkinson Co., New York.

impossible to calculate correctly the time of exposure for the three negatives. Electric arc focusing lamps of a good make, with proper carbons and a steady supply of electric current, furnish the most reliable light for three-color photography.

Instead of using color filters between the copy and the sensitive plate, the copy itself can be illuminated with colored light. For instance, the illuminant may be a powerful electric light between which and the copy colored screens are introduced. As great care, however, will be required to have these large light filters properly adjusted and maintained as if they were the smaller ones. As there are mechanical difficulties to be overcome, as will be seen, this plan is not adopted.

There are in the market what are called flaming-arc electric light lamps which, with special carbons, give a powerful light. These reduce the period of exposure greatly. In some establishments electric searchlights are used to illuminate the copy in colors. So many local conditions enter into the color of the electric light — it being influenced by the action of the lamp itself, the quantity of current and the quality of the carbons — that it is impossible to advise in this matter here.

THE LENS AND THE CAMERA.

The special feature of the lens should be its correction for chromatic aberration, so that all colored rays passing through the lens may come to a similar focus on the ground glass. Non-achromatic lenses focus the violet rays nearer the lens than the yellow rays. The violet rays, not being visible on the ground glass, are the ones that act strongest on the sensitive plate, while the yellow rays are the ones focused and are slower to act on the sensitive plate than the violet ones, consequently the violet image on the plate is out of focus. Hence, in using a non-achromatic lens it is necessary after focusing to move the ground glass forward to a point where the violet rays will be in focus.

When the photographic gelatin dry plate came into use,

sensitive to the yellow rays, lenses were constructed so as to bring the violet and yellow rays to the same focus, and such lenses were termed "achromatic." With some "achromatic" lenses the image will have to be focused through each color filter used, or three times. The difficulty of keeping the images the same size so as to maintain perfect register need not be pointed out.

For three-color photography it is essential that the lens be corrected still further so that the red rays are also brought to the same focus as the violet and the yellow ones. such lenses are called apochromatic, and through the use of special Jena glass are now to be had from all makers of first-class photographic lenses, though it is well to test each lens before purchasing.

TO TEST AN APOCHROMATIC LENS.

A chart can be carefuly drawn consisting of outline squares, as shown in the diagram:

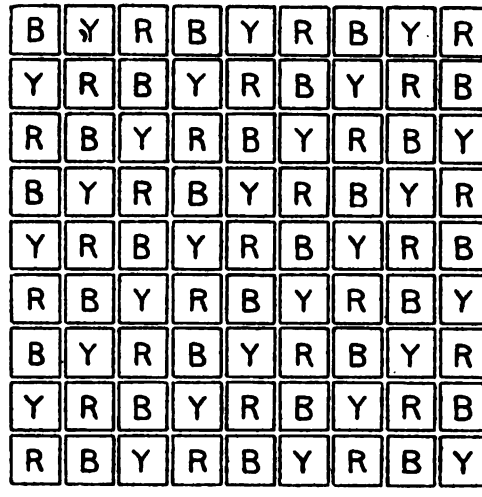


CHART TO TEST A LENS FOR COLOR CORRECTION.

These squares are drawn in outline in the color indicated by the letter in each square: yellow, red and blue. The lines should be made with a ruling pen, the lines in the dif-

ferent colors being precisely the same width, with the squares the same distance apart. The red ink can be used dilute, but should be free from any trace of blue. The chart can be one and one-half times larger than the largest plate it is intended to make with the lens, and must be focused on the blue squares.

A negative of this chart made on any of the numerous isochromatic, orthochromatic, polychromatic or panchromatic plates now on the market, or on a collodion emulsion plate sensitized for red, will give an idea of the apochromatic properties of the lens.

If any of the squares are out of focus, or if the outer edges of the squares do not form a perfect line, as in the drawing, then the lens is not suitable for three-color record negative-making.

THREE-COLOR FILTERS OR SCREENS.

The practical three-color worker should not attempt to make his own three-color filters. The makers of the color-sensitive plates and collodion emulsions have studied out scientifically the color filters best adapted to their own make of plates or emulsions. It will be a great saving of time and money on the part of the beginner, at least, if he adopt the color filters recommended by the maker of the sensitive plates or emulsions he is using.

Color filters are made in several forms. In all cases the glass used in them must be optically flat. The most scientific form of filter is the glass cell, filled with an anilin dye. These can be purchased with pipette for filling and emptying them. In another form of color filter two optically flat glasses are first coated with gelatin, then stained with the proper dye, and when dry cemented together with Canada balsam. In another a filtered collodion is substituted for gelatin as a medium for holding the dye. Screens of colored films of gelatin or collodion are also frequently used.

The three-color filters are preferably used in grooved slides immediately behind the back combination of the lens. They can, however, be used in front of the lens. Screens

of colored films of gelatin or collodion are frequently used in the slot of the lens with the diaphragm, though in the end it will be found best to use the filters in a sliding carrier behind the lens.

These screens or filters can be purchased from photo-engravers' supply houses anywhere, or from the makers of dry plates and emulsions.

TO MAKE THE FOURTH PLATE.

The fourth printing-plate is made in several different ways. Some use the red filter and get an overexposed blue-record negative, which is developed up and intensified rather hard, and possibly "cut" a little in the half-tone negative. Others make a negative on an ordinary dry plate with a piece of optically worked glass, the same thickness as the color screens, and in place of them; or, a yellow filter to cut out the actinic violet rays. Still another method is to bind the three color-record negatives together in exact register and copy them with an extremely long-focus lens, thus getting a composite positive of the shadows in all three negatives. From this positive the half-tone for the gray or black printing-plate is made.

No matter in what manner the negative for the black printing-plate is obtained, the print on the metal is etched up bright, leaving only the darkest places. The reetcher or finisher can by his skill supply any kind of a fourth plate demanded by the copy, and what these requirements are depends on the subject and whether the fourth plate is to be printed in a gray or a warm or cold black. When a fourth plate is used, the red plate must also be reduced in importance.

THE INDIRECT AND DIRECT METHODS.

There are two methods in use for three and four color block-making. The indirect method requires twelve separate photographic operations to produce a set of three-color blocks, and fifteen or sixteen operations to secure a set of four-color blocks. First, color-record negatives are

FOUR-COLOR PROCESS.
Blocks by John Swain & Son, Ltd., London.

made from the subject to be reproduced in color; secondly, positives are made from the color-record negatives; thirdly, from these positives half-tone negatives are made; and fourthly, from the half-tone negatives, prints on the metal plates.

By the direct method the half-tone screen is used before the color-sensitive plates while the light also passes through the color filters when making the color-record negatives, so that the latter are also half-tone negatives, from which the printing is done on the metal plates. The direct method thus reduces for three-color blocks the photographic operations to six, while it lengthens the time of exposure in the camera greatly, owing to the interference to light which the half-tone screen and color filters give, and the use of a prism to get the negatives reversed.

The indirect method gives much opportunity for retouching and also for local reduction and intensification in both negatives and positives to correct faults in the color-record negatives. Reversed half-tone negatives are made by simply reversing the positive. That is done by turning the film side of the positive toward the lens when making the half-tone negative from it. Formerly, plates were so insensitive to red that the direct method was impossible. Now sensitizers are at hand by which plates can be made more sensitive to red than to green.

SAFE LIGHT FOR DEVELOPMENT.

The chief difficulty in developing red-sensitive plates is to get a safe light to develop them by. The makers of red-sensitive plates supply a colored medium through which the light is to pass before reaching the red plate. If one is obliged to make safety lights, then here is one way to do it:

A green-blue darkroom light filter for developing red-sensitive plates can be made in this way: Dissolve the silver from two undeveloped gelatin dry plates by leaving them in hyposulphit of soda until they are perfectly clear. Wash the hypo thoroughly from these plates, and when they are dry stain them with the following dyes: Make a solution

of naphthol green and acidify it with a few drops of glacial acetic acid; then make a deep solution of methyl violet rendered alkaline with a little borax. Lay one of the dry plates in the naphthol green dye and the other in the methyl violet dye until they take up as much of the stain as possible; rinse in water and dry them. When they are dry, bind them together with strips of passepartout binding and they are ready to be used before the darkroom light.

For green-sensitive plates, a red darkroom light must be used. Such a filter can be made with two gelatin dry plates cleared of the bromid of silver with hyposulphit of soda. as in making the green light filter. Soak one of the gelatin-coated plates in sixty grains of rhodamin dissolved in four ounces of water, and soak the second plate in four ounces of water in which eighteen grains of aurantia was dissolved, while the water is warm. This aurantia dye works better when made alkalin with a drop or two of ammonia. When these stained plates are dry, bind together as before. Two sheets of dark ruby glass bound together also make a safe light for green-sensitive plates.

A most valuable instrument for testing the absorption of color filters and darkroom lights is a small spectroscope. The optician who supplies them will explain their use.

THE COLOR-SENSITIVE PLATES.

To make the color-record negatives it is best, theoretically at least, to use panchromatic plates, sensitive to the whole spectrum. They should be developed in the same kind of developer, its strength and temperature being the same; or they could be developed together.

It would be inadvisable to recommend here any special brand of dry plates, or any special make of collodion emulsion. There are so many kinds now in the market that each worker has plenty of choiee.

The well-known house of A. W. Penrose & Co., Ltd., of London, has just brought out a collodion emulsion which is sold as a powder. The directions for use are extremely simple. A package of the powder is put into a gallon bottle and a

quart of alcohol poured over it. After shaking it for a couple of minutes a quart of ether is added, the solution shaken until all of the powder is dissolved, after which it is filtered and is ready for use. There are five sensitizers that come with this emulsion: Sensitizing for the yellow, red, blue, black, and for ordinary half-tone reproduction.

Our own Cramer Dry Plate Works has for many years supplied most reliable color-sensitive plates. So also has Wratten & Wainwright, in England. Dr. E. Albert's eoside of silver collodion emulsion popularized that method of working, while the emulsion sold most in this country at present is that made by Sillib & Bruckman, of Munich. Many of the most successful photochromotype workers in this country are now using emulsion successfully, some of which they make themselves.

HALATION IN THREE-COLOR-RECORD NEGATIVES.

Halation, or reflections from the back surface of the glass on which the color-record negative is made, must be guarded against, particularly in the negative made through the red screen. The makers of color-sensitive plates furnish them possessing nonhalation properties if so ordered. There are many nonhalation backings on the market which should be used as directed. They are not as effective, however, as a double-coated plate or one having a substratum to prevent halation.

NONHALATION BACKING.

A paste to use on the back of the glass that will absorb the light and prevent it being reflected back into the sensitive film is the following:

Any mucilage	1 ounce
Caramel	1 ounce
Burnt sienna	2 ounces
Alcohol	2 ounces

Grind the burnt sienna in water, add the mucilage, stir in the caramel, and lastly add the alcohol. After exposure this paste should be wiped from the back of the plate with a

damp sponge. It will not injure the developer, though it discolors it.

RESENSITIZING DRY PLATES.

An important factor in three-color record negative-making is to get a plate as sensitive to the red as possible. The first dye to satisfactorily sensitize gelatin dry plates to the red was cyanin, and it was used as follows:

Cyanin, C. P.	6 grains
Absolute alcohol	10 ounces

The sensitizing bath was made, as wanted, as follows:

Of the above stock solution	1 ounce
Alcohol (ninety-five per cent)	20 ounces
Distilled water	100 ounces

This sensitizing solution was filtered perfectly into a porcelain tray, and in an absolutely dark room dry plates were allowed to soak in this bath for about five minutes, when they were removed and stood up on chemically pure blotting paper for fifteen minutes to drain, after which these plates were bathed in the following bath:

Distilled water	20 ounces
Alcohol (ninety-five per cent)	2 ounces
Aqua ammonia	½ ounce

After rinsing in this bath for a minute they were placed in an absolutely dark place and dried by an electric fan as quickly as possible.

PINACYANOL SENSITIZER FOR RED.

A most superior sensitizer for red is pinacyanol, as it has no tendency to fog the plates. One grain of this dye in two ounces of absolute alcohol makes a stock solution. For a sensitizing bath take one ounce of this stock solution, with thirty ounces of alcohol and sixty ounces of distilled water. The plates should be left in this bath for five minutes and then washed for three minutes in running water; the bathing, drying and all operations being carried on in absolute darkness.

Without the use of water in this sensitizing bath, the gelatin will absorb the alcohol and act as a filter, leaving the pinacyanol on the surface. Water carries the dye into the film.

Plates treated with cyanin lose their sensitiveness in about thirty hours, while plates dyed with pinacyanol will keep sensitive for weeks, and even then they can be resensitized without injuring them.

For collodion emulsion sensitive to red, one grain of pinacyanol is dissolved in two ounces of absolute alcohol and this added to two hundred ounces of collodion. After the collodion is flowed on a glass plate and set, the excess dye must be washed from the surface of the plate as with gelatin plates.

PINACHROME SENSITIZER FOR GREEN.

A most successful sensitizer for green is pinachrome, used in the same manner as pinacyanol, the bath being of the same strength, the bathing of the plate for the same length of time as well as the washing and drying. The only change is that the operations are performed in a weak red light, as described under "Safe Light for Development."

Erythrosin, or what the Actien Gesellschaft für Anilin Fabrikation of Berlin calls Tetraiodofluorescëin, is also a good sensitizer for green. The sensitizing bath can be made up as follows: First make a stock solution of ten grains of erythrosin in ten ounces of ninety-five per cent. alcohol. One ounce of this stock solution is used in fifteen ounces of distilled water with one dram of ammonia. This bath should, like all sensitizing baths, be carefully filtered before using. The bathed plates, when washed for five minutes in running water and dried in the dark as quickly as possible, will keep for several months.

The dyeing and washing operations are best carried out by using one of the makes of cages found in the market for washing a dozen or more dry plates by lowering them into an upright bath, which should contain the resensitizing solutions.

It is preferable to perform these resensitizing operations in the evening or the last thing in the afternoon so that the plates may be ready for use in the morning. It is better also to resensitize only sufficient plates for use during one day.

The important points to remember in resensitizing dry plates are: The cyanin must be pure, and absolute alcohol must be used to dissolve it in; the same proportion of alcohol must be used in the washing bath that is used in the dyeing bath; that these cyanin plates will not keep long and that they must be developed in the dark at first, for a minute or so, and then in a safe light, which should be a reflected, not a direct light.

To determine if the darkroom light is safe for resensitized plates, put a cyanin-dyed plate into a plateholder while in absolute darkness, pull the slide of the plateholder halfway out and expose the plate to the darkroom light for from three to five minutes. Develop this plate first in the dark, as before instructed, and see if there is not a trace of exposure on the half which was uncovered to the darkroom light. This experiment will also determine whether or not the plates are going to fog later.

The manufacturers of anilin dyes employ photographic chemists who will supply the color-plate maker with information regarding the latest sensitizers for collodion emulsion and dry plates and also how to use them.

THE EXPOSURE.

The relative exposures can be found only by experiment, for they depend chiefly on the illumination, the lens, the diaphragm, the intensity of the color filters, the sensitiveness of the plates used, and the reduction or enlargement of the copy.

It is earnestly recommended that the photographer making three-color record negatives keep a daybook in which is registered, for every exposure, the subject, kind of sensitive plate used, reduction or enlargement, lens, kind and size of diaphragm, color filter, quality of illumination

and length of exposure, together with any other data affecting the negative. Later, the kind of developer, its temperature, time of development and comments on the resulting negative should be added. This daily register will become one of the most valuable books of reference to the photographer. It will save much needless experimenting and waste of time and material.

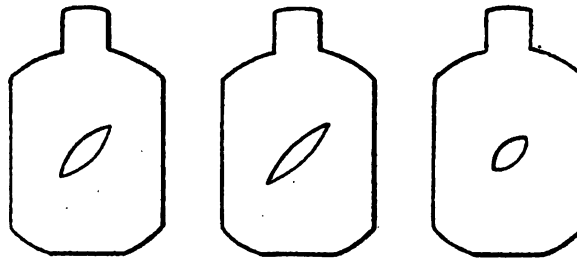
Strips of paper containing three patches of color, corresponding with those used in the printing inks, together with patches of gray, black, and white are fastened alongside of the "copy" and included in each negative made. The object of the patches of gray, black, and white is to show when the negatives are properly timed. When the gray patch approximates the same density in each of the three negatives the ratio of exposure is correct, though it must be remembered that a plate bathed in a dye will not develop as intense a negative as an unbathed plate. Therefore the gray patch in the yellow record negative will develop more intense than the similar patch in the red and blue record negatives.

THE HALF-TONE DIAPHRAGM.

If from a single half-tone three impressions were made, one in yellow ink, the second in red ink and the third in blue ink; if, also, the register was so perfect that these impressions were printed exactly over each other, the result of the three superimposed printings would appear like a single impression in black ink. Should these printings be repeated and the impressions be out of register, as they are most likely to be, then varying color effects, called moiré, will appear in the proofs.

To prevent, as far as it is necessary, the different inks from printing over each other, and to avoid these accidental color effects, it was formerly considered necessary to engrave the half-tones in lines, so that they could be printed at angles of sixty degrees to each other. Later it was found better to get cross-line effects in the shadows, lines in the

half-tones and dots in the high lights. To accomplish this with cross-line screens elliptical diaphragms were used.



ELLIPTICAL DIAPHRAGMS.

These diaphragms should be cut out of printers' press-board or ferrotype plate, with the points of the slits at angles of forty-five degrees to the vertical sides of the diaphragm, as shown in the illustration.

When in use, these diaphragms must be exactly in line with one of the lines of the half-tone cross-line screen. To insure this, the plateholder containing the cross-line screen should be put into its place in the camera, a piece of ground glass substituted for the sensitive plate, and the lens, containing one of the elliptical diaphragms, turned until the image of the slot in the diaphragm makes continuous lines on the ground glass. If the lens is fixed in this position this test as to parallelism of the elliptical stop and one of the lines in the screen need not be repeated.

To use these stops, more than one-half the exposure may be given, the lens capped, the diaphragm reversed and the remainder of the exposure made; or, a large elliptical stop may be used to close up the high-light dots in the negative, and a small elliptical stop, turned in the opposite direction to the large one, to furnish the small dots in the shadows of the negative.

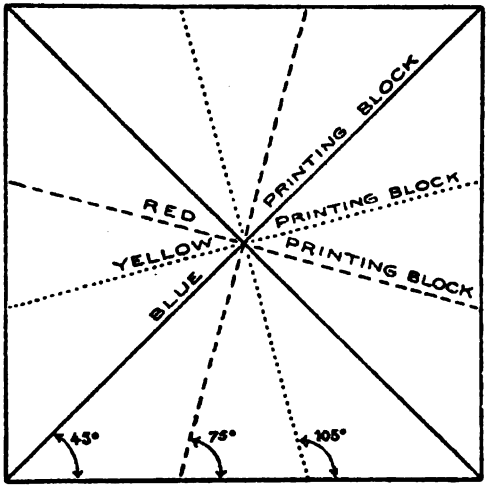
Another plan is to use these elliptical diaphragms without reversing, the effect in the half-tone being the same as if a single-line screen were used.

The reader is presumed to be familiar with the half-tone

process; it is only necessary to refer here to the additional operations in the making of three-color blocks.

TO PREVENT PATTERN IN PRINTING.

In Richmond's "Grammar of Lithography," pages 170-171, ninth edition, 1886, will be found instructions for laying down line tints for color-printing in three colors, in which it is stated: "The direction of this second series of lines is very important, and must make an angle of sixty degrees with those first transferred. The third transferring is then done, and the result should be that the lines coincide in direction with the three sides of an equilateral triangle. The reason for putting the lines so exactly in this direction is that the production of any set pattern is thus avoided."



SCREEN ANGLES FOR THREE-COLOR WORK.

Ives used this disposition of lines in his three-color block of 1881. Apparently without knowing this, Albert, in Germany, patented the use of lines at sixty degrees to each other in 1891; Du Hauron, unaware of its having been used before, received a patent on it in France in 1892, and Kurtz, thinking it an original discovery with himself, obtained a United States patent on it in 1893.

So the angle of sixty degrees, which lithographers found, generations ago, to be necessary in laying down tints, is the proper one for the three-color-block maker of to-day.

The screenmakers furnish two cross-line screens for three-color half-tones that are well worth adopting. One is the ordinary cross-line screen ruled with lines at forty-five degrees to its sides. The other is a special screen made to match the first one both as to thickness of lines and the spaces between the lines. The lines of the second screen are ruled at angles of seventy-five and 105 degrees to its sides. This screen can be used one way for the yellow printing block and reversed for the red printing negative. Owing to this reversal the two glasses of which the screen is composed should be of the same thickness.

The best plan of all to produce half-tone negatives, with one line thicker than the other, is not to depend on the uncertainty resulting from timing the changes in the elliptical stop but to have the cross-line screen itself engraved with lines of different thicknesses. In this way round stops may be used, and in every negative made with it one of the crossed lines will preponderate. Should a half-tone be required from such a screen with the crossed lines of equal thickness, recourse may be had to the elliptical stops again, and by giving the greater exposure with stop turned in the direction of the thin line, normal half-tone screen effects can be had.

CAMERA WITH CIRCULAR SCREEN.

A more satisfactory way, and one necessary in the direct method, to get the screen angles in colorwork just right, is to use a circular screen in a camera constructed purposely for colorwork. Such a screenholder has the degrees clearly marked so that the precise angles can be had quickly and with absolute certainty.

As to the angles for four-color printing blocks, it has been found best to retain the angles of the stronger color — black or gray, blue and red at thirty degrees separation, and introduce the yellow at fifteen degrees between any two

REPRODUCTION OF AUTOCHROME IN FOUR PRINTINGS
BY J. HORACE MCFARLAND COMPANY

of them. Many four-color block makers use a mezzograph screen for the yellow printing block, thus avoiding danger of a moiré pattern.

THE PROCEDURE IN THREE-COLOR BLOCK MAKING.

The previous chapters have told of the necessity of an apochromatic lens to bring the red, yellow and blue rays to precisely the same focus. It has been recommended to purchase color filters, or screens, darkroom lights and sensitive plates, or emulsions. It is also better to depend, for instructions in the development and handling of whichever brand of plate that is used, on the dry-plate maker. Instructions for using collodion emulsion are usually given by those who supply it. Just how to resensitize dry plates for special sensitiveness to the red has been carefully described. The danger of halation, the necessity of a reliable source of illumination for the copy, and the value of a register of the exposures and after-treatment has been urged. How to make the diaphragms and the kind of half-tone screens and camera to be used has been pointed out. Having all these requisites we will now go over the operations in making three-color blocks by the indirect method.

We will assume that a water-color sketch is to be reproduced in color. Everything about the camera must be fixed firmly so that there shall be no change in the relative position of either copy, lens, or sensitive plates during the making of either negatives or positives. Remember to have patches of the three colored inks, to be afterward used in the printing, as well as patches of white, gray and black, attached to the copy, so as to be photographed in each negative. Also have registry marks at all four sides of the copy.

EXPOSING THE COLOR-RECORD NEGATIVES.

The blue-violet filter is cleaned and inserted in its slide behind the lens, and the copy focused to its proper size. Diaphragm the lens down until the image is sharp on the ground glass at every point. Cap the lens and insert the holder containing the blue-sensitive dry plate, draw the slide one-third the distance, and expose the plate for what

might be considered one-half the time required for the whole exposure. Cap the lens again, draw the slide out two-thirds of the way, and expose for the same period of time as the first; then draw the slide out entirely, and expose once more for the same length of time. Do not fail to make a record of all this in the daily register. Development of this test plate will give an idea of the proper exposure for future plates. Repeat this time of exposure test with the green filter on the green-sensitive plate and on the red-sensitive plate with the red filter.

The exposure through the green screen is liable to be longer than through the blue-violet screen, while the exposure through the red screen may be less than the exposure through the green screen, if the red-sensitive plate has been bathed in pinacyanol.

The relations of the exposures vary, as has been said before, with the illumination of the copy, as well as the kind of copy, its reduction or enlargement, the density of the color filters, the kinds of plates used, whether collodion emulsion or gelatin dry plates, as well as their development, so that the operator must determine for himself through these time tests the proper exposures to be given.

DEVELOPMENT.

It is not necessary to go over the method of dry-plate development. Sufficient is it to caution against the danger of fogging the green and red sensitive plates by light in the darkroom. It is best to flow the developer on these plates in absolute darkness, and allow the development to proceed for at least a minute before turning up the light that is considered safe. A record should be taken of the time required in development.

REDUCTION OR INTENSIFICATION.

After perfect fixing and a good washing, should the negatives not correspond in density, this can be remedied by carefully intensifying the weak negative and reducing the strong one.

Positives are made from the three-color record negatives, on either dry or wet plates, as the operator prefers. Equally good positives can be produced by either method. The positives represent in their shadows just how much ink of each color will be used in the printing. One with a well-trained eye for color separation can determine by comparing them with the original copy whether they possess the proper color balance — that is, whether the colors will be in the proportion they are in the copy when printed over each other. The proper color balance can be restored by careful reduction or intensification of the positives either locally or over the whole plates. The yellow plate is usually corrected by painting on the glass side of the positive with a semitransparent color so as to obstruct the light when printing through it. Small areas like lines may be reduced by scraping the film on the positive with a sharp knife.

THE HALF-TONE NEGATIVE.

The positives could be placed in a rotary holder in a copy board, and turned to the proper angles before making the half-tone negatives, or, better still, be fixed one after the other in exactly the same position in the positive holder, and the half-tone screen rotated as is done in the direct method.

ETCHING THREE-COLOR BLOCKS.

There is no difference in the method of etching plates for three-color and etching plates for black printing, except that it is better to etch all three plates together so that the color balance may be preserved. The registry marks having been preserved on the half-tone plates, the plates are turned over to the printer to prove them. If, after proving, it is found that one color overbalances the other by being too strong, the strong plate can be given a further etching, or, either of the plates can be reetched locally where necessary.

SCREEN ANGLES FOR FOUR COLORS.

To avoid moiré, or a pattern, in superimposing screens in four-color printing it is necessary to cross the lines at the most obtuse angles possible. With a cross-line screen in

each printing this angle is, of course, 22½ degrees from each other. Still there is a danger of pattern unless the stronger colors, blue and black, are kept farther apart. It is found better to have 30 degrees between the blue and black, and 15 degrees between the red and yellow. Be also careful to put the yellow between the red and blue. With the circular screen the following angles may be chosen: Black to blue, 30 degrees; red to yellow, 17½ degrees, yellow to blue, 17½ degrees. The following positions give the least moiré pattern and for other visual reasons are the most practical angles in which to use the four screens: yellow, 75 degrees; red, 60 degrees; blue, 90 degrees; and black, 120 degrees.

PRINTING THREE-COLOR BLOCKS.

It is within the power of the printer, by skilful underlaying of the plate, to modify the result in any way he pleases, so that corrections can be made in many ways. There should not be any corrections for the printer to make after he receives the final set of proofs from the maker of the plates. The ink should correspond with the color patches photographed with the copy The best inks to use are the ones employed by almost all three-color printers. It was not intended to give in these few chapters instructions in presswork or the kind of presses to use. Presswork is a business entirely distinct from three-color block making, and it is only the latter the writer has tried to the best of his ability, though briefly, to explain.

OFFSET-PRESS WORK IN NINE PRINTINGS.

An example of the Knapp Aquatint. By courtesy of the Knapp Company, Inc., New York. Art publication branch of the American Lithographic Company.

PHOTOPLANOGRAPHY.

PRACTICAL

APPLICATIONS OF PHOTOENGRAVING PROCESSES TO THE OFFSET PRESS.

The photoengraver is most anxious to help out the offset-press printer if the latter could but explain how it could be done; but, as neither is too well acquainted with the other's method of working, it is too often a case of the blind leading the blind, when both get away from their proper course.

The photoengraver makes plates for dry-paper printing. He cares little whether water repels grease or vice versa, while the offset pressman is a "grease-and-water artist." His work is founded on the fact that grease and water will not mix. His printing-ink must have some grease in it, and the plate from which he prints must be dampened with a roller wet with water before it is rolled with ink. The offset press will occupy the field it is intended for when there is a better understanding between the photoengraver and the offset pressman as to what are the requirements and the limitations of each.

Photolithography will answer all the requirements of the offset press when it is properly worked, though there are few processworkers that know anything about it. The methods used in the most successful photolithographic establishment having been described fully, we will now consider how the regular photoengraver may apply to the offset press some of the methods in every-day use in his plant.

GRAINED ZINC OR ALUMINUM AND LITHOGRAPHIC STONE.

It might be well first to explain how it is that grained zinc has taken the place of lithographic stone as a printing surface and to correct the statement so frequently made that "zinc has exactly the same properties as lithographic stone." The facts are, that owing to its porous nature lithographic stone will absorb grease and water with equal facility, while a polished piece of zinc will absorb no more water than a piece of glass. Hold a piece of polished zinc under the tap

or allow it to soak in water all day and see how the water is still repelled by it. Flow water over a piece of ground glass and it will be found to retain some moisture, and here we find the principle by which zinc has been adapted to take the place of stone. The surface of a zinc plate can be ground to hold moisture to a greater degree than a ground glass surface, owing to the fact that when the surface of zinc is scratched with the proper cutting material its ductile surface is plowed up into minute furrows crossing one another at every conceivable angle. These furrows or gutters in the metal hold moisture by not only capillary attraction but by what is called cohesion or surface tension. And these scratches in the zinc hold hardened grease in the same manner, so that by creating this artificial surface on the zinc it mechanically holds grease and moisture, while lithographic stone has the same property through its natural power of absorption.

ZINC FOR OFFSET-PRESS WORK.

Zinc can be grained by hand, but it is a long, tedious operation requiring great patience and much skill. The thickness of the metal used is from ten one-thousandths to forty one-thousandths of an inch. Regular 14-gauge zinc used by photoengravers is eighty-three one-thousandths of an inch, so that the offset press zinc at its thickest is not one-half as thick as that used by some engravers.. There is a still thinner zinc used to pull transfers on, called "foil" or "wafer" zinc, so that the difficulties of graining such thin metal by hand can be understood. There is a right and a wrong side to the zinc sheet, and the difference is found usually by laying the sheet in a tray containing nitric acid in the proportion of one ounce of acid to twenty ounces of water and brushing the acid solution over both surfaces with a bristle brush. The surface that etches smoothest is the surface to be grained.

GRAINING THE ZINC BY HAND.

The sheet of zinc should be first clamped to a block made for that purpose and the bends required by the clamps should

PRINTED ON OFFSET PRESS

COURTESY NIAGARA SILK MILLS

LITHGRAVURE BY
GIES & CO., BUFFALO

How I Became a Nurse

PRINTED ON OFFSET PRESS

COURTESY CHAUTAUQUA SCHOOL OF NURSING

LITHGRAVURE BY
GIES & CO., BUFFALO

correspond to the gripper bends on the press, so that they need never to be rebent when the zinc is regrained. Instead of grippers to hold the sheet secure to the block while graining it may be tacked to the block at the corners. The graining materials are the same as those used in a graining-machine, and the pressure on the graining material must not be too heavy; a block of wood covered with an iron plate being as good as any weight to press the cutting sand on the zinc surface, while this iron-faced block is moved around in small circles.

The best advice that could be given here is to not attempt to grain your own plates by hand. Better purchase them already grained, as photoengravers do their polished zinc and copper. Plates grained by machine are so far superior to those treated by hand that should the amount of work warrant it a graining machine is a most essential addition to the plant.

THE GRAINING MACHINE.

A graining machine is a water-tight wooden box as large as, say, 4½ by 6 feet, and about 5 inches deep. It rests at the corners on large steel balls and is given a vibratory or rotary motion by mechanism underneath the box. The plates to be grained are fastened by clamps to the bottom of the box (as many plates as will cover the bottom of the box) and covered with emery, pumice or sand, and sufficient water to float the sand. Then the sand is covered with marbles and the machine started vibrating from 150 to 200 revolutions a minute, with the result that the marbles, while moving but a short distance, press the cutting material into the plate and produce scratches in curves crossing each other in all directions. The time required to grain a plate varies from thirty to ninety minutes, depending on the cutting material and the quality of grain required. In some establishments the sand is changed every twenty minutes.

THE MARBLES USED.

The balls used to roll over the plate may vary in size from one-half inch to 1 inch in diameter and can be made

of hardwood, stone, glass, glazed porcelain, or steel. The white pebbles found at the seashore are also used. On the character of grain required depends the kind of marbles as well as the scratching material used. When any of the marbles get flat on one side they are called "flat wheels" and must be thrown out. It requires as many as 5,000 marbles of a single kind to cover a metal plate in a graining-box of the size mentioned above. Glazed china and steel marbles are the ones most used, while wooden marbles are still used for aluminum — a metal softer than zinc. Wooden marbles are also used where the finest grain is required on zinc, the rule being that the finer the grain required, the lighter or smaller should be the marbles and the finer the scratching medium; while the coarser the grain, the heavier or larger the marbles and the coarser the sand used.

THE SCRATCHING MATERIAL.

The grain given to a metal surface may vary from the finest matt to the coarse and visible grain used for posterwork. These grains are given numbers which correspond, in a measure, with the number of the graining material used. For instance, the No. "000" grain is produced with "000" emery, and so on through "00," "0," and No. "1," which is given with No. "1" sand, silex, flint sand or carborundum, or any material that can be sifted through a screen with a mesh 120 to the inch. This No. "1" grain is called a medium grain, suitable for the majority of work both in transferring and in retaining moisture on the press. For one of the first things one learns in offset printing is that the transferrer prefers the finer grains while the pressman has least trouble with the coarser ones; for the reason, chiefly, that the transferrer can get solids easier on a fine grain, while the coarser grains hold the moisture better and thus prevent "scumming" on the press.

The coarser grains are numbered 2, 3, 4, 5 and 6, the latter being used for the coarsest posterwork.

Above all things, do not trust the graining of the plates to an unreliable person, remembering that the whole success of the work is based on the preparation of the plate, and good work can not be done on an improperly grained plate.

FURTHER POINTS ABOUT GRAINING.

Great care must be used in taking the grained plate out of the box to prevent scratching it. This may seem strange. Though the surface of the plate is covered with millions of scratches, a single one in a straight line would spoil it. As all of the marbles must be removed and the box cleaned out free of scum before another plate is grained, some of the marbles can now be taken out, the plate released from the clamps in the corners and then drawn slowly from the box, washed thoroughly in running water, back and front, taking care not to touch the face with the fingers, and dry as quickly as possible. The plate is then ready for treatment by the transferrer. Should the grained plate be stored away for a long time before use it is well to remove the slight trace of oxid that may have formed, by plunging the plate into a bath of nitric acid — two ounces to a gallon of water — for a few minutes and then wash off the loosened oxid under the tap with a clean sponge.

If it is an aluminum plate use hydrochloric acid instead of nitric.

To regrain a plate, first remove the old transfer from the plate with turpentine, and then get rid of the turpentine with a strong solution of potash and a scrubbing-brush. After washing the potash thoroughly from the plate it is then put into the graining-box for a fresh graining.

PHOTOGRAPHIC PRINTING ON GRAINED METAL.

The photoengraver will find the following the easiest and most satisfactory method of getting a print in line or half-tone on a grained zinc plate for printing on the offset press.

He must provide himself with powdered asphalt, good quality benzol and spirits of turnpentine. The asphalt need not be light-sensitive, and it would be better to wash it well with water to remove any soluble dirt and filter the water

from it. Then wash it with alcohol to remove any material in it that may be soluble in alcohol. Should the asphalt discolor neither the water nor the alcohol, then it is sufficiently pure and does not need that treatment afterward. Evaporate the alcohol from it by putting it on clean paper in a warm closet and then make up a solution of:

Powdered asphalt	½ ounce
Benzol	10 ounces

Filter this asphalt solution perfectly. While it is filtering fasten the sheet of thin grained zinc to a wooden block by tacking it at the corners. Flow the grained zinc with the filtered asphaltum and whirl and dry as usual. When the asphalt coating is perfectly dry, flow it with the regular sensitizing solution for metal on hand, whether it be albumen or enamel.

If it is necessary to prepare a sensitizer the following will answer:

Water	16 ounces
Albumen, whites of two fresh eggs	2 ounces
Bichromate of ammonia	40 grains

The albumen should be well beaten up with an egg-beater before being stirred into the water, and ten drops of water ammonia, twenty-six per cent, added to the solution after the bichromate of ammonia is dissolved in the albumen mixture. Filter this carefully through cotton wool.

Hold the asphalt-coated grained zinc under the tap for a few moments, drain well, and flow with the filtered albumen solution several times, letting the first coating pass away in the sink. After flowing it from different corners, at least three times, place it again in the whirler and dry the albumen coating. Or, the zinc plate can be detached from its wooden support, and flowed and dried by laying on a previously heated thick zinc or copper plate. The things to be avoided chiefly are specks of dust drying in the albumen coating; heating the plate so hot that it will coagulate the albumen; and the injurious effect of coal-gas heat, which has almost the same effect on bichromatized glue, or albumen, that light has.

All the previous operations have, of course, been carried on in a room lighted by yellow light, as well as the present one of putting the metal plate in contact with the negative in a printing-frame.

EXPOSURE TO LIGHT.

The printing-frame should have a sheet of soft, pure, rubber backing behind the zinc plate and plenty of pressure to bring the sensitized surface of the zinc into intimate contact with the film side of the negative. A pneumatic printing-frame is best for this work.

The exposure to light must be found by experiment and should not exceed three to four minutes of sunlight, or enclosed arc electric light. An actinometer is a valuable aid here to determine the length of exposure.

After exposure the zinc plate is taken from the printing-frame in a darkroom and laid in a tray containing the following dye bath:

Water	35 ounces
Methyl violet	8 grains

The tray is rocked until the image appears darker in color than the beautiful golden yellow of the asphalt ground. It is then washed with a hose under the tap quickly and flowed over with alcohol to completely coagulate the albumen. After draining off the alcohol it is dried in a darkroom. If the alcohol is diluted over one-half with water it will be found to coagulate the albumen more evenly.

DEVELOPING WITH TURPENTINE.

When the plate is thoroughly dry it is placed in a tray containing:

Spirits of turpentine	20 ounces
Benzin, good quality	4 ounces

The grained zinc will begin to show almost immediately between the lines and around the dots. Should the white dots in the shadows of a half-tone, for instance, not show clearly, development may be assisted with a tuft of cotton applied lightly to the film. Rocking the tray hastens the development. Just as soon as the image stands out clearly

the plate is once more washed thoroughly under the tap until all greasiness disappears, when it is ready to be desensitized, rolled up and treated by the offset pressman, or transferrer.

TO SHIP THE PLATE WITHOUT INJURY.

To protect the plate from injury during shipment all that is necessary to do is to cover the image on the zinc plate with a light protective varnish of shellac laid on with a brush. When the plate reaches the offset pressman he simply washes off the protective varnish with alcohol, and all traces of alcohol under the tap, and the plate is again ready for use to pull transfers from after the usual treatment with acified gum arabic solution, called the desensitizer.

Where this method of photographing on grained plates is in use it is a good plan to coat the grained plates with asphalt immediately after they are grained and dried. This prevents oxidization of the zinc. It must be remembered that the asphalt coating is sensitive to light and can not be washed from the plate after it is light-hardened, so that asphalt-coated zinc plates should be kept in a dark place.

After asphalt-covered plates are developed, exposure to light is a benefit to them as it hardens the asphalt image further.

ENAMEL SOLUTION ON GRAINED PLATES.

The enamel solution found in any engraving plant may be used on the asphalt-coated grained zinc plate in the same manner as the albumen solution previously described. It is exposed to light for the same period used in photorelief printing, and after printing the enamel is rolled up with transfer ink and developed as is done in albumen printing on polished zinc.

Great care must be taken that none of the greasy ink is rubbed into the grained zinc, for it can not afterward be removed. In fact, this is the great danger in this enamel method. If the plate is developed in running water and kept well covered with clean water there is little danger of ink getting into the grain when ordinary care is taken.

After development the plate is washed well under the tap, whirled to get rid of the surface water and dried quickly. It can then be heated slightly to bring the transfer ink together, and be turned over to the offset pressman or coated with shellac varnish for shipment away.

GUMMING UP A GRAINED ZINC PLATE.

The action of gum arabic in repelling greasy ink is well known to lithographers, and photoengravers should at least understand the principles governing its use.

Gum arabic or gum acacia, from the tree it exudes from, is obtained best from Senegal. It contains an acid which etches lithographic stone or zinc slightly, so that if a fresh solution of gum arabic is brushed over a grained zinc plate, allowed to dry on it and then washed off with a sponge and the plate dried again, it could then be put in an offset press, dampened and rolled with the dampening roller and ink, without any danger that the plate would take up ink from the roller.

It will be understood, then, in either of the methods of photoplanography given here, that after the metal plate is developed, washed and dried, it can be flowed with the fresh gum arabic solution, which is allowed to dry on the plate. The gum arabic can not reach the plate where it is covered with asphalt, while the gum renders the zinc repellant to grease wherever it is allowed to act upon the plate.

It has been found advantageous to add other acids to the gum arabic solution. The acids most used are citric, gallic, tannic, oxalic and phosphoric. Their use on a metal or stone surface is called 'desensitizing."

DESENSITIZING SOLUTIONS FOR METAL PLATES.

The following are the desensitizing solutions most frequently used by offset-press transferrers:

Gum arabic, from Senegal	½ ounce
Water, distilled	8 ounces
Phosphoric acid, in solution	½ dram

The gum arabic should be powdered in a mortar and stirred into solution with a glass rod. The phosphoric acid

comes in sticks, also in a fifty per cent solution and this is the better way to buy it. There is a syrupy solution of phosphoric acid sold which is an eighty-five per cent solution. It should be diluted to make a fifty per cent solution, as it is more convenient to measure.

Another desensitizing solution preferred by some transferrers is —

Water, distilled	20 ounces
Gum arabic, from Senegal	1 ounce
Phosphoric acid, solution	½ dram
Gallic acid	½ ounce

All desensitizing solutions should be filtered before use and should be used fresh, as the tendency with gum arabic solutions is to turn sour quickly. When it does get sour a little powdered chalk is used to sweeten it, though a little carbolic acid, oil of cloves or cinnamon, or gum camphor is used in the desensitizers sold ready for use, to prevent fermentation in them.

SPONGES MUST BE CLEAN.

Everything used while working on a grained zinc for the offset press must be clean. Clean water and absolutely clean sponges are necessary. The sponge used for one purpose should not be used for any other, and there should be a plentiful supply of clean water at hand.

Aluminum plates on the offset press have a tendency to get lighter while printing from them; zinc plates on the press have a tendency to get heavier, or thicken, so that the gumming-up on a zinc plate must be properly done. There is a tendency for the grease in the printing-ink to repel water from the edges of every line and dot on the plate, and after driving away the water encroach itself on the water areas. This information gives the photoengraver warning to make transfers or prints on zinc as sharp as possible and lighter than heavier in thickness of lines or dots.

USEFUL INFORMATION REGARDING PHOTOPLANOGRAPHY.

Photolithographic transfers for the offset press should

HIGH-LIGHT HALF-TONE.

Copyright by Harper & Bros., from a drawing by Vernon Howe Bailey.

The Walker Engraving Company, New York.

be reversed as regards right and left. That is, they should read backward.

Photographic prints direct on the grained zinc for use on the offset press should read to the right.

Photolithographic transfers for planographic printing direct from the metal should read to the right.

Photographic prints direct on the metal for planographic printing direct, and not by offset, should be reversed.

The best transfers for planographic printing can be made from photointaglio engraved plates.

Grained zinc plates will oxidize, and so will grained aluminum plates, if they are not kept away from moisture.

Do not scrape out the grain on a metal plate to remove dirt or make corrections.

Half-tone negatives for planographic printing should be made by a high-light half-tone method.

HIGH-LIGHT HALF-TONE NEGATIVES.

For the offset press and frequently for relief plates a high-light half-tone negative is wanted. That is a negative in which the highest light dots in the copy are filled up. Such negatives are usually made in a camera specially fitted with a frame holding the screen which can either be withdrawn entirely from the camera or the frame holding the screen can be swung inside the camera out of the way. When making high-light negatives in such a camera the exposure is made through the half-tone screen as usual, and then the screen is removed and an exposure of one-sixth to one-tenth the time given to the copy without the screen. No flash exposure is used. On development the high lights should fill up so that with proper intensification they will not print either on photolithographic transfer paper or on metal.

Another and simpler method is this: After the regular exposure is made, move the half-tone screen as far from the sensitive plate as possible and make another exposure with the high-light stop for, say, ten seconds, or enough to fill up the highest lights on intensification.

The writer made high-light half-tones as early as 1879 by putting an ordinary negative and a half-tone screen together and getting a half-tone positive from the combination. It is now called the Sears process, and some firms are paying a royalty for the use of it.

GUM SOLUTION FOR ROLLING UP ZINC.

Before pulling offset transfers and sometimes after a very slight first bite, if the image is delicate, some operators roll up the zinc with a soft transfer ink after "gumming up" the plate, as it is called. The gum solution they use is the following:

Water	15 parts
Saturated solution of gum arabic	10 parts
Phosphoric acid	1 part
Gallic acid	5 parts

This solution is spread over the zinc with a flat camel's-hair brush and allowed to remain a half minute or more before being wiped off with a clean and damp sponge. The ink for rolling up should contain a little middle linseed oil varnish.

THE VANDYKE PROCESS.

This process was patented in the United States in 1880 and was known as Hagotype. The principle of the process is that weak hydrochloric acid will soften bichromatized albumen or gelatin that has been hardened by the action of light. It is utilized in this way: After an inked image has been developed on a zinc plate by the ordinary bichromatized albumen method, it has under the ink an image in hardened albumen. The plate is dried and rolled up with a thin but perfect coating of good quality etching-ink, warmed slightly so that the ink will attach itself intimately to the bared zinc. The plate is then laid in a weak hydrochloric acid bath for a few minutes, or until the acid has had time to soak through the ink coating and attack the albumen image under the ink. The plate is then developed by gently rubbing with cotton wool, when a reversed image will appear on the zinc which can be resined and etched.

ROTARY PHOTOGRAVURE.

The Rotary Photogravure Co., Passaic, N. J.

ROTARY PHOTOGRAVURE.

THE NEW

PHOTOMECHANICAL METHOD WHICH GIVES MOST ARTISTIC RESULTS ON INEXPENSIVE PAPER.

The latest and most valuable application of photography to the printing-press, so far as artistic results go, is the engraving of photogravure on a cylinder so that a web of paper can be printed from it at high speed. It is the ideal method for illustrated periodicals. Germany led in its use for this purpose, though an illustration from a photogravure on a cylinder was shown in an Austrian magazine in 1897. In the Process Year Book for that year, page 125, Mr. William Gamble describes the method.

Potters have for generations cleaned with a knife blade the ink from intaglio plates from which they print the designs for transference to pottery. Wall-paper and fabric printers who use intaglio engraved rolls to print from have for many years used what they call a "doctor," which is a sharp steel blade, to clean off the surplus ink from the roll. Marinoni, the famous pressbuilder of Paris, built a rotary photogravure press in the eighties in which the wiping of the plate was done by means of a doctor as in wall-paper printing.

The engraving of the roll by photography was not perfected then and it remained for Karl Klic, to whom we owe so much in photogravure, to perfect the method of engraving rolls for rotary photogravure printing. As usual he kept his methods secret. Many fine art reproductions were produced in colors in England toward the close of the last century as the result of Klic's skill, the Rembrandt Intaglio Printing Company's photogravures, made in that way, being highly prized by art lovers everywhere.

The publication in *The Inland Printer* of December, 1908, of a photogravure in colors, a realistic reproduction of a portrait in oils, made the whole printing world realize that an improved method of reproducing colors in printing-

ink had arrived in the United States. To Mr. Charles W. Saalsburg's perseverance must be credited that accomplishment.

ROTARY AND FLAT PRINTED PHOTOGRAVURE.

The essential difference between rotary and ordinary photogravure, printed from flat plates, is this: The photogravure on the cylinder must be engraved in such a manner that the deepest shadows will have continuous bearings for the metal wiper or doctor, or, in other words, that the ink-holding cavities on the cylinder be in the form of cells surrounded by thin walls of the metal cylinder. This will be explained later. The most successful way of accomplishing this was worked by Klic and an Austrian named Klisch, and has been in use by the Rembrandt Intaglio Printing Company in England since the late nineties.

Another method is to etch on the cylinder a half-tone intaglio, instead of in relief, taking care that at least single lines of the metal cylinder remain even in the deepest shadows to act as bearers for the metal wiper, or doctor. By examining with a microscope the screen lines in a photogravure print the two methods may be distinguished.

THE KLIC AND KLISCH SCREENS ON THE CYLINDER.

These pioneers of rotary photogravure found it best to separate the etched areas of the cylinder with fine lines, leaving the cells for holding the ink of the same dimensions but of different depths. To make their method more easily understood we will take a screen of transparent thin lines ruled on glass at angles of forty-five degrees to its sides and crossing each other so as to leave opaque squares instead of transparent squares, as in an ordinary half-tone screen. Now if a print is made from this screen on a piece of photogravure carbon tissue and it is squeegeed in contact with a copper cylinder, then developed and etched with chlorid of iron until the protected lines of the screen threaten to be eaten away, it will be found when printing from such a cylinder on a rotary photogravure machine,

with a doctor for wiping away the surplus ink, that the resulting print will be in rich, velvety tones, the lines of the screen being completely obliterated.

The screen lines are intact on the roll, with square cells between them. These cells are left quite full of ink when the doctor passes over them, while the screen lines, level with the surface of the cylinder, are wiped clean of ink by the doctor. The elasticity of the impression on soft paper causes the pyramids of ink, after leaving their cells on the cylinder for the paper, to run together and give the effect of a solid, rich, velvety depth of color which can not be obtained by any other machine-printing method, and it is this rich, velvety color that gives the strength and value to photogravure.

Should these same cell walls or partitions be cleaned with a rag, as in hand-printed photogravure, much of the ink would be wiped out of the ink cells unavoidably. Further, when using a metal wiper instead of a rag a much thinner ink can be used.

The screen lines on the cylinder, besides producing the necessary cell walls, act as bearers for the doctor and prevent the roll from wearing as soon as would be expected with long editions. In fact, they are what make rotary photogravure printing possible.

PHOTOGRAVURE ON A CYLINDER.

The ordinary photogravure-worker, or those who have studied the chapter on photogravure in this book and who fully appreciate the necessity of screen lines on the cylinder for rotary photogravure, will require to know the further steps to engrave photogravure on a cylinder.

The cylinders can be solid copper rolls; or better, hollow copper cylinders slightly tapered on the inside so that they can be forced on a mandrel. Some of the latest cylinders are steel tubes on which a shell of copper has been deposited by electrolysis. These rolls are turned absolutely true in a lathe and polished there, the polishing of a cylin-

der being even a more mechanical operation than polishing a flat plate.

WAYS FOR GETTING THE SCREEN LINES IN THE RESIST.

The pitch of the screen employed is generally 150 to 175 lines to the inch. Should the negative be made in the camera, the screen can be inserted in front of the sensitive plate and in contact with it if the latter is a dry plate. A short exposure to a sheet of white paper covers over the negative with a network of screen lines of equal thickness throughout and does not interfere in the slightest with securing all the gradations of the copy in the negative.

A second method of impressing the carbon tissue with screen lines is done either before or after making the print from the ordinary positive on the tissue. This requires a second print on the carbon tissue from the half-tone screen for sufficient time to print the lines on it. This method is the common practice.

A third method, preferred because it prevents the possibility of "devils" in the metal, is the following: Two sheets of carbon tissue are printed, one from the transparent line screen which is transferred to the cylinder first and developed there; then a carbon print from the positive which is transferred on top of the screen already on the cylinder and also developed. When both films dry down, the relief made does not interfere with etching. As Mr. Huson has found that "devils" are caused by minute pinholes in the gelatin tissue, which permit chlorid of iron to go through and etch those pits called "devils" in the copper, this double tissue on the cylinder prevents this annoyance for the reason that pinholes in one of the tissues are covered up by the other.

PREPARING THE CYLINDER AND TRANSFERRING.

The metal cylinder, like a copper plate, must be carefully prepared to insure the gelatin adhering to it during the etching. This is a most important matter. If the surface of the cylinder could be grained, the resist would stick; but this

is impossible, as it would leave a tint in printing. The cylinder must keep its polish and yet the gelatin must adhere to it. One way to accomplish this is as follows:

After the roll is treated with clean potash solution to remove the grease, it is washed and gone over with one dram of sulphuric acid in ten ounces of water. This removes the stain caused by the potash and gives the copper a slight tooth. When the acid solution is washed from the roll thoroughly the metal is dried quickly and painted over with the following substratum, which makes the tissue adhere during etching:

Two hundred grains of a hard gelatin, like Coignet's "Gold Seal," is dissolved in ten ounces of water; ten grains of chrome alum are dissolved in one ounce of water. Both solutions are heated slightly, and while the gelatin is being stirred briskly the chrome alum solution is poured slowly into the gelatin. While the clean, dry and warm copper roll is turned, it is given, with a flat brush, a thin coating of this substratum, after which it is allowed to dry in a place free from dust.

TRANSFERRING AND DEVELOPING THE TISSUE.

Information regarding the preparation of the positive and printing the carbon tissue will be found in the chapter on photogravure as the operations are similar, the only difference being that the printed gelatin resist must be transferred later to a cylinder instead of a flat surface.

The copper cylinder can be arranged to turn in a trough of cold water in which the printed carbon tissue is put to soak. Care must be taken to remove air-bells from its front and back surfaces. When the tissue begins to flatten, it is quickly adjusted to the position indicated by pencil-marks which have been drawn on the cylinder. All the water possible is pressed out, the cylinder raised from the trough, the tissue squeegeed securely to the cylinder, and all surplus moisture wiped from the back with soft cloths. The roll is allowed to "set" for at least ten minutes while the trough is being prepared with water of about 110° F.

As copper absorbs and holds heat, it is well, if the roll is a solid one, to allow only its surface to dip in the warm water when developing. The roll is steadily turned over the developing trough until the paper backing is loosened, when it is stripped off and the development continued. Local development can be given to the tissue by pouring the warm water from a pitcher or from a vessel with a small spout when small areas in the tissue are to be treated. When the image shows proper development, the tissue is treated with alcohol and water, gradually increasing the alcohol until pure alcohol is used to drive out all the water possible from the film, when the roll can be revolved rapidly and dried. It is now ready for covering the margins with asphalt varnish.

ETCHING THE COPPER ROLL.

The method of etching a cylinder is similar to that of etching a flat plate, except that the cylinder must be rotated in a trough containing the etching solution. In practice, fewer changes in the strength of the mordant is found necessary. For some subjects a chlorid of iron bath of 32° Baumé will be found to work satisfactorily.

The important point to be observed in cylinder etching is that the screen lines are not etched away, for it must be again recalled that on the preservation of these lines as partitions between the ink cavities and as bearers for the metal wiper the whole success of rotary photogravure printing depends.

After cleaning the asphalt protection from the roller with turpentine and benzin and removing the gelatin resist with potash the photogravure roll is ready for the press.

OTHER METHODS OF ROTARY PHOTOGRAVURE.

Dr. Eduard Mertens showed on Easter Sunday, 1910, in a supplement to the *Freiburger Zeitung*, of Freiburg, Germany, excellent photogravures printed on ordinary newsprint paper. Since then several papers have used his method with success. Dr. Mertens engraved a half-tone intaglio,

as the writer was doing in New York in 1894, except that Dr. Mertens etched his intaglio half-tone on a cylinder with the advantage that the metal wiper leaves the intaglio cavities fuller of ink than the rag wiper does on a flat plate. His method differs from Klic, Klisch and Sallburg, from the fact that, instead of using a carbon tissue for the resist on the metal, Mertens coats the entire cylinder with bichromatized gelatin and prints from a positive half-tone direct on the cylinder.

DR. EDUARD MERTENS' METHOD.

To coat the cylinder with the bichromatized glue, Dr. Mertens uses a simple apparatus whereby the glue solution is flowed on the cylinder in a spiral.

The bottle containing the sensitized glue is on an elevated stand from which the solution flows through a glass cock and rubber tube to a bent and pointed glass tube, from which it flows in a spiral stream on the cylinder, which is mechanically revolved in a lathe and at the same time moved laterally. The convolutions of the spiral stream of glue immediately merge into each other and form a continuous coating of the sensitive material. The rate of coating is about 1½ inches a minute. The drying of the coating is assisted with an air-blast.

THE MERTENS NEGATIVE AND POSITIVE.

Dr. Mertens first makes a continuous tone negative, from which he makes a half-tone copy through a slit diaphragm, which gives him a positive largely in lines running in one direction, particularly in the deep shadows. These lines are at an angle of forty-five degrees to the axis of the cylinder, so as not to interfere with the movement of the doctor when wiping the cylinder later. The positive has pure whites in the highest lights and a full range of gradation from black to white. This positive is coated with rubber and collodion, and stripped from its glass support and used as a pellicle on the cylinder by drawing it in contact with the cylinder with another transparent film over this pellicle.

It can also be secured to the sensitized roll with castor oil, as is done in photographic printing on stone.

MERTENS' METHOD OF PRINTING ON THE CYLINDER.

To get a photographic print on the sensitized cylinder, it is exposed to eight mercury vapor lamps the full length of the cylinder. These lamps are enclosed in light-tight boxes and in a semicircle, so that light can fall only on the cylinder perpendicularly. As the lamps will not work unless raised at one end, the cylinder must also be placed at the same angle as the lamps while it is slowly revolved. The exposure lasts from eight to fifteen minutes to lights with an aggregate intensity of about four thousand candle-power.

After printing and development the glue film may be "burned in" to form an enamel acid resist, as in ordinary half-tone etching. The etching of the roll then becomes a simple operation, quite similar to that of ordinary half-tone and permitting reetching to vary the effects.

TRANSFERRING AN ENAMEL RESIST TO THE ROLL.

A. Villain suggested in the *Process Photogram* for July and August, 1898, a method of attaching a film of resist to metal plates or rollers. His idea worked out in the following manner would give a perfectly practical process for engraving rolls for fabric and wall-paper printing:

If the reader will make up an enamel solution as given in the chapter on half-tone and will apply this enamel to paper as told in the instructions for coating paper for photolithography in this book, he can then print on this paper from a positive that is reversed, as regards right and left, and develop the paper under the tap as enamel is developed on metal. Having the copper roll perfectly clean, as recommended in the chapter on the Rembrandt method, the paper containing the developed gelatin enamel print is squeegeed in position on the roll and allowed to dry perfectly.

When the paper-coated film on the roll is absolutely dry, the roll is turned slowly over a single or double piped gas

stove with sufficient flame to burn off the paper the whole length of the roll. The charred paper can be removed with a brush and the burning-in of the enamel proceeded with as explained in the chapter on half-tone enamel.

Before etching and after the roll is properly protected with asphalt, the carbonized enamel on the roll should be brushed vigorously with a mixture of one ounce of hydrochloric acid in ten ounces of water to which three ounces of common salt has been added. It will then be seen if the design on the roll requires retouching or any parts need scraping away before etching. The etching can be done with a single bath of chlorid of iron at about 32° Baumé. The enamel roll is cleaned with strong potash, washed and dried.

UTILIZING A DAGUERROTYPE IMAGE ON A ROLL.

The idea of etching a daguerrotype plate so that it could be printed from, which was tried out so thoroughly after the daguerrotype was given to the world in 1839, has at last been solved in New York by Mr. Carleton and others associated with him. It is utilized chiefly for engraving copper rolls either in relief or intaglio for printing on fabrics or paper, so that if rotary photogravure printing does not become popular it will not be because the methods of applying photography to engraving the rolls are limited.

TRANSFERRING ENAMEL TO A ROLL.

A novel enamel method suggested by J. M. Hascher is applicable to copper rolls as well as flat plates. It also possesses the advantage of dispensing with a reversed negative. His enamel is composed of:

Coignet's superfine gelatin	100 parts
Water	1,000 parts
Bichromate of potash	30 parts
Liquid ammonia	10 parts
Pure glycerin	60 parts

The gelatin is swelled and dissolved in 700 parts of water and the bichromate in 300 parts of water. Both solutions

are heated to 86° F., and the bichromate slowly poured into the gelatin solution; filter once and add the ammonia and glycerin and keep at 104° F. in a dish. Float well-glazed paper on this and dry in the dark. The dry paper is printed under a half-tone negative until the image is plainly visible in brown. The copper plate, having been cleaned with alcohol and chalk, is taken into the darkroom, and the paper containing the half-tone print and the copper are placed in a dish of cold water at the same time. When the paper becomes flaccid it is floated on the copper and squeegeed to it. After blotting off the water the plate is allowed to stand for a quarter of an hour until the swelling of the gelatin fixes the film firmly to the plate. The copper plate is then turned face down on hot water of 105° F. until the paper loosens, when it is carefully removed. The light-hardened gelatin adhering to the copper is then washed gently under the tap, dried, and the gelatin burned in as in the enamel process.

ORDINARY CROSS-LINE SCREEN.

ROTARY PHOTOGRAVURE SCREEN.

EVERY PROCESS PHOTOGRAPHER

SHOULD BE

FAMILIAR WITH THE FOLLOWING FACTS AND FORMULAS.

MUTILATION OF COPY BY ENGRAVERS.

In one of the early numbers of *The Inland Printer* was an editorial crying out against the mutilation of copy by engravers. One of the paragraphs was as follows: "No one who has much to do with ordering processwork can have failed to remark the general disregard which engravers seem to have respecting the condition in which the original copy is returned to the customer. This fault is not the fault alone of cheap houses. It is prevalent among the best engravers, and it is as unnecessary as it is annoying."

This editorial was copied into various trade papers and did much to stop the evil. There is still opportunity for improvement in this matter. There are still firms who permit their men to hammer a valuable drawing full of ten-ounce carpet tacks to secure it to the copy board. There is no excuse for this. There are several inventions now for securing copy to the plan board by the use of clips of various kinds and sizes. If a tack must be used there are glass-headed push-pins that will not mutilate copy to the extent of a nail or tack. Any engraver who can not devise means of securing copy to a board without driving spikes through it had better go out of business at once, for he will eventually drive away all his trade anyhow.

NUMBERING DIAPHRAGMS.

Every diaphragm possesses a focal value which is the relation of its diameter to the equivalent focal length of the lens to which it belongs, and it should be numbered accordingly. To find this number divide the equivalent focus of the lens by the diameter of the circular aperture in the diaphragm. For example: The focal length of the

lens is 12 inches and the diameter of the diaphragm is ½ inch, then 12 ÷ ½ = 24. The number of the diaphragm is therefore 24 and is marked thus, f/24. This system is a most convenient one, as it assists in the calculation of exposures. The exposure varies as the square of the area of the stop. For instance: If f/8 stop requires ½ minute exposure, under the same conditions f/11 would require 1 minute exposure; f/16, 2 minutes; f/22, 4 minutes; f/32, 8; f/45, 16; f/64, 32; f/90, 64 minutes; each smaller stop requiring twice the exposure of the preceding one.

EQUIVALENT FOCUS OF A LENS.

The equivalent focus of a process lens is the focus of parallel rays entering the lens. It is usually found by focusing the lens on an object over 150 feet away and then measuring the distance between the diaphragm and the ground glass. This is the equivalent focus. Another way is to focus any piece of copy exactly same size, then measure the distance exactly between the copy and the inner surface of the ground glass. One-quarter this distance will be the equivalent focus of the lens.

SUBSTITUTE FOR GROUND GLASS.

The best substitute for a broken ground glass is another ground glass and it is very easily made. Take a few cents' worth of finely powdered emery, dust it over a sheet of flat plain glass, wet it with water, and then, with a flat iron or another piece of glass, rub the emery with a circular motion over the glass. It does not take long to make a new ground glass in this way.

A varnish which, flowed on plain glass, gives very much the effect of ground glass is made by mixing two ounces of ether, one ounce of benzol and one-fourth ounce of alcohol. In this dissolve powdered sandarac or dammar in the proportion of from ten to twenty-five grains to the ounce. It dries quickly and without heat.

PHOTOGRAPHING SILVERWARE.

It is well known that polished silver surfaces reflect light in such a way as to make it impossible to photograph them properly. One way to overcome the mirror-like surface is, if the silver is a vessel that will hold water, to fill it with ice-water just before photographing. This causes moisture from the air to be condensed on the silver surface and prevents reflections. A second method is to dab the silver over with fresh putty. This deposits on the silver a film of oil and whiting which also destroys reflections. The third way is to heat on an iron plate some muriate of ammonia (sal ammoniac). When the salt burns it gives off a smoke which deposits a white oxid on the silver surface that is held in the fumes. This oxid deposit can be wiped off without injury to the silver surface.

GLASS CLEANING.

When the negative films on glass are old there is no better solution to soften them up than a mixture of bichromate of potash, sulphuric acid and water. It can be made as follows: To every gallon of water add sixteen ounces of sulphuric acid and two pounds of bichromate of potash. This solution can be used for a long time. The old negatives are laid in with separators — small pieces of lead — between them. The films should be softened in twelve hours. The films are scraped off and saved with the silver waste, and then the glass is given a good scrubbing with a stiff brush and plenty of clean water. The edges of the glass should not be neglected.

ALBUMEN SUBSTRATUM.

In building a structure of any kind it is most important that the foundation be right, so in wet-plate negative-making it is necessary that the substratum on which the negative is built up be perfect, and there is none that can compare with the old reliable albumen made up in the following way:

One ounce of fresh egg albumen is beaten to a froth, mixed in forty ounces of water, and one dram of water ammonia added. The whole is well filtered and flowed only on one side of thoroughly cleaned glass.

WHY OLD COLLODION GIVES SHARPER NEGATIVES.

Photoengravers find that new collodion gives a fuzzier negative than old collodion; while the latter, though slow, makes a sharp, crisp negative. The reason for it is probably this: The old collodion being a dark amber color acts as a color screen and prevents halation in the negative. To prove this, remove the amber color from the old collodion by the addition of a few grains of carbonate of soda, which destroys the amber color but prevents the collodion from producing as sharp a negative.

INCREASING EXPOSURE.

Exposure must be increased as the square of the area of aperture in the stop decreases. Exposure also increases in proportion to the square of the camera extension. The absorption of light by a mirror used in reversing negatives increases rapidly as the mirror becomes tarnished. The use of a prism usually doubles the exposure and the period of exposure increases with the size of the prism.

COLLODION EMULSION OR DRY PLATES FOR COLORWORK.

As to whether dry plates purchased from a reliable maker, or collodion emulsion, also from a reliable source, is the more economical and satisfactory, is a question in which there is no agreement among practical men. Some color-plate makers use collodion emulsion exclusively, while others producing equally good work prefer dry plates. In either case the supply house either furnishes a demonstrator to show how their goods are best used or they supply

full printed working instructions. Dry plates have the advantage of being always ready, can be used anywhere and developed at any time, while they usually give cleaner negatives. Collodion emulsion, on the other hand, can be handled much like a wet plate and almost any character of a negative can be had from it by intensification and after-treatment. The drawback to collodion emulsion was that it was rarely free from dirt specks. This trouble has been overcome in some of the newer emulsions.

PRESERVATIVE FOR DEVELOPED PLATES.

There are occasions when an operator wants to expose and develop all the wet plates he can and leave the intensification until later. The writer was the only out-of-door photographer connected with a daily paper in the world during the years 1876-79. He carried with him collodion, silver bath, and developer. When photographing paintings in an art exhibition or documents in a public library, he only developed the plates and flowed them with: Water, three to four ounces; glycerin, one ounce, and acetic acid, one-fourth ounce. This solution was flowed over the well washed and drained developed plate, and it was put in a grooved plate box and fixed and intensified at night.

BLACK SPECKS ON NEGATIVES.

Whenever black specks appear on a negative after development it is usually due to some form of sulphur in the bath. It usually comes when hard rubber trays or holders are used for the bath. If you employ a glass bathholder you will be safe except from the rubber dipper used to raise and lower the glass to and from the bath. Sulphur is used to vulcanize the hard rubber, and if the latter is not kept varnished it will give those black specks. All hard rubber utensils should be thoroughly cleaned in strong soda solution, dried thoroughly, and lacquered with a thin shellac varnish to which sufficient lampblack is added to make it a good black.

RESTORING AN "OVERCUT" NEGATIVE.

It will often happen that an operator has "overcut" a negative in one spot and does not want to throw the negative away. Let him take a little of the iron developer and add to it a few drops of the silver solution from the bath, just enough to turn it slightly brownish. Now with a dropping tube drop this iron-silver solution carefully on the spot to be strengthened. It had better be done in the darkroom to avoid fog and carefully watched so as to not overintensify. When the spot is considered sufficiently strengthened, wash the negative and blacken in the usual way.

LEAD INTENSIFIER.

One ounce of nitrate of lead and one and one-half ounces of ferricyanid of potassium are dissolved in sixteen ounces of hot water, which gives a saturated solution; two and one-half ounces of acetic acid is then added. After fixing, the negative is cleared with one ounce of nitric (or hydrochloric) acid in twenty ounces of water. The lead intensifier is used in a porcelain tray and the negative laid in it. After a few minutes' rocking, the negative is bleached white. It is then well washed under the tap and flowed with one ounce of either sulphid of sodium or ammonium in twenty ounces of water. Should the negative show any tendency to stain, the acid solution previously mentioned will clear it up.

GRAY BORDERS FROM BLACK DRAWINGS.

If solid black borders on white paper are photographed through a screen until the white paper high-light dots are closed up entirely, and then the whole drawing covered up with a sheet of white blotter so as to give a flash exposure long enough to make small dots over the blacks, a half-tone negative is had of the black border in half-tone dots surrounded by high lights, representing the white background, so closed up that they will not print on metal.

FOG AND ITS CAUSES.

What is termed "fog" in wet-plate photography is an obscuration over a portion or all of the negative after development. It may arise from the silver bath, from the collodion, or from diffused light in the plateholder, the camera box, or the darkroom.

A new silver bath will cause a fog over the whole plate if it is alkaline or is not iodized sufficiently. A few drops of c. p. nitric acid will cure the alkalinity, and leaving a collodion plate in the bath until it absorbs sufficient iodin will cure the other fog. An old collodion will frequently work with a new bath when new collodion will give fog. The bath or developer being too hot will bring about fog, and so will fumes from sewer gas, coal gas or from a kerosene stove. Fumes of ammonia and hydrosulphuret of ammonia are sure causes of fog. Diffused light in the camera may come from a small hole in the front board of the camera box, or from reflected light entering the lens, or from too much light in the darkroom, or stray light getting in through a hole or crack in the partitions. These are causes of fog over the whole plate.

Fog coming from stray light, called light fog, is in the film; while fog that comes from the bath itself or developer, called chemical fog, usually lies on the surface of the film and can be removed with a piece of wet cotton.

When fog is produced by light leaking into the camera box or plateholder it shows itself in streaks over the plate, and these point to where the light comes from, so the trouble may be remedied.

Impure nitrate of silver and old white crystals of sulphate of iron will cause fog, and so will an insufficiency of acetic or other acid in the developer, so that eternal vigilance is the price of freedom from fog, though skilled operators never experience this trouble.

TO PURIFY A SILVER BATH.

For a played-out silver bath of one gallon procure a three-gallon porcelain evaporating dish, pour into it half a gallon of water and into this water pour the old silver bath. It will make a yellow solution, caused by the iodids that are set free. These can be filtered out. Then put the bath in the evaporating dish over heat and boil down until it becomes a yellow, pasty mass. Continue the heat until it gives off brown fumes. Shut off the heat from under the dish, and while the residue is cooling keep stirring it until it breaks up into particles like brown sugar. Dissolve this sugar-like salt in the amount of distilled water you require to make the bath up to the proper bulk. Put it in the sun, in a clear glass bottle, for a few days until it is clear. Filter, strengthen with nitrate of silver up to 45°, test for alkalinity with litmus paper. If it is not acid, add c. p. nitric acid until litmus paper in it just turns red and you have a perfect silver bath.

PINHOLES IN NEGATIVES.

The appearance of small transparent spots in the negative after development is one of the troubles of the wet-plate photographer and it is likely to come from the following causes: Dust on the glass is a most prolific cause, and this dust may be induced by brushing the surface of the glass briskly during cold weather with a fine-haired dust brush. This electrifies the glass and causes any dust in the air to adhere. Of course, dust in the collodion will also produce pinholes and these can be eliminated by filtering the collodion. When the bath is new, pinholes can be caused by insufficient iodid in the bath; and when the bath is old, because of too much iodid in the bath solution. The first condition is cured by allowing a plate coated with collodion to remain a long time in the bath, and when the bath is overcharged with iodids the best remedy is to evaporate it down to dryness, as told elsewhere.

DRY PLATES IN PROCESSWORK.

Dry plates are coming more and more into use in processwork. The makers of each brand of plates furnish such complete instructions for their use that it is unnecessary to give any directions here. Where copy can be had only in a public library, or private building, or can not be brought to the processworker's studio, then dry plates must be used. Panchromatic and tri-color plates can be used for the color separation, where the copy is in colors; and contrast dry plates, with glycin or pure hydrochinon development, when the copy is in line or a half-tone negative is required. All photoengravers should be acquainted with contrast dry plates and their development. One thing that should be said is, that where a photographer's time is constantly employed at process negative-making the wet-plate process is far more economical, besides giving more suitable negatives. Where a process negative is required only occasionally, then the dry-plate method may be used.

SUBSTITUTES FOR IODID OF POTASSIUM.

To dissolve the metal iodin in water, iodid of potassium is commonly used, but as the latter is a most expensive chemical the following substitutes have been suggested: Dissolve the iodin to saturation in denatured alcohol and then add this alcoholic solution to water to make, with cyanid, the cutting solution or to iodize the plate in intensification.

Or, use caustic potash as follows:

Iodin	75 grains
Caustic potash	35 grains
Water	10 ounces

Dissolve the caustic in two ounces of the water and then dissolve the iodin in this strong caustic solution. After which add the rest of the water and then nitric acid drop by drop until the solution turns a rich wine color. Should too much acid be added a precipitate is thrown down, which more caustic will take up. This solution does not keep well.

DARKROOM VENTILATION, HEAT AND DUST.

To ventilate the darkroom and keep out the summer dust is largely a question of construction. There is much economy in having the darkroom cool, clean and well ventilated. Besides sparing the health of the operators it saves many a make-over, which is not only a great waste of chemicals but what is more costly — the waste of a valuable operator's time.

Ventilators should be at both floor and ceiling, trapped for light and covered with muslin on a frame that can be removed and brushed clean daily. As most darkrooms are located where the heat is most uncomfortable in summer, negatives will be found to fog. The cure for this is to keep the chemicals cool. Ice can be used in the darkroom to great advantage. The collodion especially should be cool, then the bath, and lastly the developer. Each operator can judge for himself how best to utilize ice for that purpose, and a few pounds of ice properly used will be paid for in the better and greater quantity of work that can be turned out. A proper temperature in winter is just as essential in the darkroom.

SCHLIPPE'S SALT INTENSIFIER.

After bleaching the negative with either copper solution or iodin and washing well it can be turned into a beautiful scarlet color, which is strongly nonactinic, by flowing it with five to ten grains of Schlippe's salt to each ounce of water. Schlippe's salt is sodium sulphantimoniate and is obtained by dissolving sulphid of antimony in sodium hydrate and adding sulphur. Should this scarlet negative not be dense enough it can be treated with copper and silver, which gives a most intense black.

ZINC AND COPPER ETCHERS

HAVE PAID

MUCH MONEY FOR THESE FORMULAS AND METHODS.

ALBUMEN SENSITIZER WITH GLUE.

The writer has found the addition of a little glue to the albumen formula used in sensitizing zinc makes the exposed print develop quicker, which is important on a newspaper. He used:

Water	25 ounces
Albumen of two fresh eggs	2 ounces
Le Page's glue	½ ounce
Ammonium bichromate	45 grains

Enough water ammonia is added to this solution, drop by drop, to turn it a straw color.

ASPHALT PROCESS.

As the purified Syrian asphalt can now be purchased in a powdered form, those who wish to try this oldest and most perfect of the photoetching processes, and have plenty of time to give the exposure to sunlight, will find the following to be a simple way to proceed successfully: Dissolve one ounce of the purified Syrian asphalt, or bitumen of Judea, as it is sometimes called, in about twelve to fifteen ounces of pure anhydrous benzol. Filter through cotton several times into an amber bottle, as the solution is affected by light. To prevent it being too brittle it is necessary to add a little oil, say one dram of oil of lavender and also one-eighth ounce of Venice turpentine. In a dark room, flow this over a metal plate and whirl to get an even coating. It dries so quickly that it is better to secure the plate in the whirler, polished side up, and then pour some of the asphalt solution in the center and whirl. Evaporate the benzol out thoroughly and then print for, say, thirty minutes in sunlight to several hours on a cloudy day. Develop the plate in turpentine and wash the turpentine from the plate with a strong stream of water. It is ready to etch at once.

THE DRY ENAMEL PROCESS.

The following process is still being sold as a secret. It is prized highly by those who have the patience to handle it properly. As the coating is a hygroscopic one, changing in character with the amount of moisture in the atmosphere, it is not entirely practicable in places where the climate is subject to sudden changes as is the case in coast cities. In its simplest form it is as follows:

Water	10 ounces
Albumen (whites of two fresh eggs)	2 ounces
White rock candy, or white sugar	½ ounce
Bichromate of ammonia	¼ ounce
Chromic acid	75 grains
Aqua ammonia	¼ ounce

When this solution is mixed and filtered it is flowed on the copper plate as the regular enamel, dried and printed under a negative as usual. Instead of developing with water it is taken into a dampened room and brushed over with finely powdered anhydrous carbonate of soda until the image stands out clear. One can get all kinds of effects by breathing on the plate. If powder should stick to any portion of the plate where it is not wanted, a little finely powdered salt will remove it. Now burn in the enamel as usual and develop with cold water, rubbing away the powder with a wet sponge. To remove scum from the plate try a little damp salt or a very weak potash solution. Carbonate of magnesia may be used in place of the soda for development. Dextrin may be used in place of the rock candy or sugar, in fact every operator using the process has his own secret formula.

SCUM ON ENAMEL PRINTS.

So prevalent is the appearance of scum after the development of an enamel that most etchers use a clearing solution, before submitting the developed print to the chlorid of iron, either in the tub or the etching machine. The principal causes for scum might be enumerated briefly as follows:

Imperfect cleaning of the metal; portions of a previous print being left on the copper; the negative not being sufficiently intense, particularly in the shadow dots; the enamel being too thick; enamel solution too new or too old; bad bichromate, or the solution too acid; too long a time between coating the plate and using it; too long a time between printing and developing it; overheating the plate when drying, particularly when it has albumen in it; drying over a poor gas stove when the fumes injure the enamel; fogging the plate by exposing it, at some time after sensitizing and before development, to too much light; lack of contact in printing; too much heat from the arc lights when printing; too much exposure; underdevelopment when in too much of a hurry; insufficient washing both before and after staining the plate with a dye; bad quality dye.

ZINC RUINED BY OVERHEATING.

Zinc is peculiarly affected by temperatures, and roughly stated the changes are about as follows: Zinc when cold or at normal temperature is somewhat brittle, but heated above the boiling point of water — 212° F. to 300° F.— it is quite ductile and malleable, and it is at the latter temperature it should be rolled. In the rolling some sheets may be allowed to get hotter than they should and thus lose their ductility. At between 300° F. and 400° F. zinc becomes brittle, and it should never be heated above 400° F. when burning in the enamel upon it, for above 400° F. the character of the metal changes entirely. It becomes brittle, and remains so on cooling. Copper is heated to 700° F. when burning in the enamel upon it, and as some zinc melts at that temperature it can be understood that enamel can never be carbonized on zinc as it is upon copper. Zinc should never be heated above 400° F., for the change that takes place at that temperature not only destroys the cohesiveness of the metal but tends to loosen the enamel coating from the zinc.

COLD-ENAMEL PROCESS FOR ZINC.

What has been termed a cold-enamel process suitable for zinc, where there is danger of destroying the zinc by heat, is as follows: The prepared zinc is covered with a thin and even coating of carefully filtered asphalt solution in turpentine. When this asphalt is dry, wash the greasy surface from it with either a little alcohol or ammonia in water. When water flows on it readily, sensitize the plate with either enamel or bichromatized albumen; print and develop as usual. When the developed print is dry, develop with turpentine, which will remove the asphalt from the portions you wish to etch, the enamel coating protecting the asphalt in the light-hardened parts. In this way is gotten an asphalt resist on metal in a few minutes exposure. Shellac or dragon's-blood varnish can be used in place of asphalt, and alcohol instead of turpentine used to develop it after the colloid is developed.

ANOTHER COLD-ENAMEL PROCESS.

An excellent cold-enamel process for zinc can be had by flowing the zinc first with a thin and even film of dragon's-blood, or shellac, dyed red, in alcohol; then flowing with a bichromatized enamel. The enamel is printed, developed and dried, and then the plate is immersed in alcohol for about ten seconds, when it is taken out and washed under the tap. The alcohol softens the dragon's-blood or shellac and the quick dash of water washes off the alcohol and dislodges the softened varnish from the metal before the water has had time to soak through the light-hardened glue. The plate can now be further developed with a tuft of cotton, and with the aid of the water from the tap all the alcoholic varnish that was softened by the alcohol can be removed. If some of the light-hardened enamel comes away it does not make any difference, because the dragon's-blood or shellac image on the metal is the best possible acid resist, with the further advantage that it is in intimate contact with the metal.

THE DRAGON'S-BLOOD POWDER-BOX.

The writer described in *The Inland Printer* a form of container for the dragon's-blood powder that is being generally adopted. In nearly all plants the powder is kept in a high box, with an open front. Into this front is brushed the surplus powder from the plate. Now if this box was made dust-tight, with a door in front that would slide up and down like a window sash, no dust could get out when the box is not in use. If the back of the box is of muslin, drawn taut on a frame, and an electric fan is placed back of this muslin enclosed in an air duct opening to the outer air, you have a powder-box that will not allow any powder to escape into the workroom. The proper way of using such a box is this: The raising of the front door should start the fan going, which draws the air into the box and through the muslin at the back of the box. The powder is filtered from the air by the muslin and deposits on the surface of the muslin, from which it can be brushed occasionally. A tinsmith will make an air duct to enclose the portion of the back of the box covered with muslin, and make the duct funnel-shaped so that it just encloses the fan and then continues out of the window. Each engraver can use his ingenuity to fit this idea to his own situation.

THE AUSTRIAN ETCHING PROCESS.

The plate is sensitized with asphalt, printed, developed with turpentine, washed and given a good first bite. It is then gummed and rolled up with a thin ink diluted with oil of spike. The plate is heated until the oily ink melts and runs down the sides of the line, forming a big shoulder. The plate is powdered with finely ground asphalt. Asphalt that sticks to the bottom of the plate between the lines is scraped away. Then the plate is etched until the shoulder is eaten away. The plate is again rolled up with soft ink, heated until the ink runs down as before, then powdered with asphalt and proceeded with as before until three bites

are given. After which the plate is cleaned of all acid protection, inked up again and powdered, and an effort made to get rid of the shoulders. The method requires hours, which is considered no drawback to the process in Austria.

STRENGTH OF ETCHING-BATHS FOR ZINC.

The question of the strength of the etching-bath for zinc depends on the strength of the acid, the quality of the zinc, the character of the image to be etched, the strength of the acid resist, the temperature, and whether the etching is to be performed in a tub or a machine. The makers of machines supply instructions for the acid solutions to be used in their machines, so we will only consider the tub here.

The nitric acid is usually purchased at 40° Baumé in strength, and it should be tested to see that it is that strength. The first bath can be anywhere from one ounce of nitric acid to from twenty to eighty ounces of water. Both solutions will etch ordinary "hard" zinc; it is only a question of time, the weak bath requiring so much longer time. Experienced etchers, on a newspaper for instance, will use a first bath of one ounce of acid to ten ounces of water on strong work.

With the second etching it is all a question once more of the character of the work and the depth of the first bite. It is customary to add only about double the quantity of acid used the first time. The period of the second bite may be not longer than the first one.

For the third bite the quantity of the acid added can be double the amount already in the bath, and the etching period can also be double that of the second bite. For the fourth bite more acid can be added than was added for the third bite, and the period of etching also increased. The period of any bite ends when the finest dots or lines in the plate show a tendency to be undercut.

Successful etching can be learned only by experience.

FACTS FOR FOREMEN AND FINISHERS

AND FOR

WORKMEN AND APPRENTICES AT PROCESSWORK OF ANY KIND.

COINS FOR WEIGHTS.

Should a process man be without weights he can use United States coins to weigh chemicals and the weights will be found approximately as follows:

A silver dollar and nickel will weigh about.....	1 ounce
Half-dollar and a dime will weigh about.....	½ ounce
Half-dollar will weigh about.....	200 grains
A dime and a nickel will weigh about.....	¼ ounce
A nickel will weigh about.....	⅛ ounce
A cent will weigh about.....	50 grains
A dime will weigh about.....	1/12 ounce

POINTS ABOUT WEIGHTS AND MEASURES.

An ounce of metallic silver contains 480 grains, while an ounce of nitrate of silver weighs only 437½ grains. Metallic silver is sold by troy weight, while nitrate of silver is sold by avoirdupois weight. All solid chemicals are sold by avoirdupois weight, while most photographic formulas are written in apothecaries' weight. For instance, a photographer buys negative cotton in ounce boxes to make collodion; each box contains 437½ grains (troy), while his formula calls for 480 grains, an apothecaries' ounce. He buys, however, 16 ounces or 7,000 grains in a pound, while his formula calls for but 12 ounces or 5,760 grains. Another fact which the processworker is liable to forget is that, in fluid measure, the U. S. pint contains 16 ounces while the British pint calls for 20 ounces.

DRAGON'S-BLOOD.

This resin, used so extensively in metal etching as an acid resist, is an exudation from trees of the genus *Dracæna* and others. It is from the rattan palm *(Calamus draco)* of the East Indies that most of the crimson-red resin, used

by etchers, comes. When in sticks it is called reed dragon's-blood, though it is most frequently imported in dark red chunks known as lump dragon's-blood. It melts at 248° F. Its specific gravity is 1.196. It is soluble in alcohol, benzin, chloroform, carbon bisulphid, glacial acetic acid and caustic soda or potash. Insoluble in kerosene, petroleum, ether, and only sparingly soluble in turpentine or ether. The pure resin may be obtained by dissolving the powdered article in alcohol, filtering out the residue and evaporating the alcohol. For the purpose of powdering and brushing against the sides of etched lines, dragon's-blood is more satisfactory if not entirely pure.

FISH GLUE.

Fish glue is a common kind of isinglass and is made, as its name indicates, by boiling the heads, tails and skins of fish. A preservative is used in it to keep it from putrefaction. It is the basis of the acid resist used in copper etching and called enamel.

TO MAKE PERCHLORID OF IRON SOLUTION.

In case one is out of perchlorid of iron for etching copper it is well to know that one can prepare it by dissolving wire nails or piano wire in four parts of muriatic acid to one part of nitric acid. This should be done in a stoneware vessel, out of doors, as the fumes are horribly dangerous. The mass is stirred from time to time with a glass rod. When the acids have taken up all the iron they will, a solution is obtained, largely perchlorid of iron with some nitrate of iron and free acid, but it will etch copper all right.

RETOUCHING VARNISH.

When an image is developed on zinc or copper, either by the albumen or enamel methods, it is necessary to examine it carefully, with a magnifying glass if necessary, to see that there are no breaks or defects in the ink or enamel images. If so, these holes or defects must be stopped out with red sable brushes and a slow-drying varnish that will

absorb etching-powder. An etcher should have a set of at least three red sable brushes ranging from the finest to, say, a No. 3.

The retouching varnish can be made by softening a little of the etching-ink with either turpentine and oil of lavender, or both by preference. This can be mixed to any consistency in a small saucer, which is inverted when not in use so as to escape dust. An etcher generally treasures the fine-pointed sable brushes that he has "broken in" and will clean them out with turpentine at night when he is through with them. There is a retouching crayon made by Korn that all etchers should have at hand.

VARNISH FOR PLATE BACKING.

There is no better varnish for protecting the back of metal plates from the action of acids than asphaltum. It is easily prepared by dissolving the lump asphalt in benzin. It is well to add a little oil of lavender to prevent it drying too brittle. This varnish is applied to the back of metal plates, while they are warm, with a broad bristle brush. It is removed by heating the plate and using either strong potash or benzin.

REMOVING MAGNESIA FROM FINISHED HALF-TONES.

When an enameled copper plate is etched it is customary to fill in the etched parts with magnesia to learn the state of the plate. This dispenses with proof-pulling. When reetching is done, the magnesia, though not interfering with the mordant, combines with the chlorid of iron to make a solid substance which is difficult to remove even with a stiff brush. It can be removed by laying the half-tone plate in a weak nitric acid bath and then brushing the plate under the tap. An ounce of hydrochloric acid and an ounce of salt in ten ounces of water will remove it. So also will a dram each of chromic and sulphuric acids in twenty ounces of water. In fact any solution used for removing scum from the copper plate before etching will with the aid of a brush dislodge the magnesia from a finished copper plate.

OILS USED IN TRANSFER INK.

The oils useful in transfer and etching inks may be classified into vegetable and animal oils, drying and non-drying oils, and solid oils.

The most useful oil is made from linseed, or flaxseed. Expressed from the flaxseed cold, it is a light yellow in color. Drawn from the seed with heat, it is a dark brown and not so valuable as the cold-pressed. It is liable to be adulterated with cottonseed oil, which is not a true drying oil like linseed. Boiled linseed oil has been heated to about 300° F. It dries quicker than the raw oil.

The other drying oils are Scotch fir-seed oil, poppy-seed oil, walnut oil, hempseed oil, hazel-nut oil and the oil from tobacco.

Among the non-drying oils are castor oil, olive oil, mustard oil and rapeseed oil. None of these should be used in ink.

The solid vegetable oils valuable in transfer and etching inks are: Bay wax, palm oil, cocoanut oil, Japan wax, and cocoanut oil and butter.

The animal oils are non-drying oils and consequently not so useful. Mutton tallow is used in transfer ink, while lard, neat's-foot oil, stearin (which is insoluble in cold alcohol), and olein, the liquid portion of fixed oils and fats are not recommended for transfer or etching inks.

ACID-PROOF DUSTING POWDERS.

The etcher has a great number of substances that can be finely powdered and used to dust up the ink image on metal or be used to brush against the sides of the etched line. Dragon's-blood leads in efficiency. Then there is the old reliable asphalt, which has a tendency to cling together and not stay powdered. Ordinary resin or colophony makes an excellent white powder. Then there is lac, or shellac,

mastic, sandarac, dammar and copal, all with different melting points, so that combinations of these different resins are sold under various proprietary names. It is not generally known that after charging the inked print on metal with one powder, say resin, it will take more powder if another powder is used immediately, say dragon's-blood. And also that graphite can be used to advantage on top of a powder and before melting. That is when "topping."

WAXES AND RESINS IN ETCHING-INK.

The waxes used in etching-ink are: Beeswax, which should be from the honeycomb (usually adulterated with paraffin and other things); palm-tree wax, carnauba wax, Chinese and Japanese wax.

The most valuable resins in etching-ink are asphaltum, Canada balsam, Burgundy pitch, lac, frankincense, copaiba balsam, and colophony or resin.

STOPPING-OUT VARNISH.

The varnish used by finishers, or reetchers, for stopping out portions of the plate before reetching, is usually made of shellac. A saturated solution of ordinary unbleached shellac should be kept in one bottle and some of this diluted with alcohol for use. It can be dyed a strong blue so as to show strongly on copper, or dyed red if used on zinc.

Chinese or Japanese brushes in bamboo handles are admirable for use in stopping out. When not in use the tips can be left in alcohol.

To remove stopping-out varnish, alcohol had better be used.

AQUATINT GRAIN.

There are many times, outside of tint-blocks, in which the processworker would like to secure a grain on a plate when a grain box is not at hand. It can be done by flowing on the plate a mixture of resin and alcohol. As the alcohol

evaporates, the resin forms in fine grains all over the plate. These grains can be secured firmly to the plate by heat.

Another method is to lay a wax ground on the plate, and while the ground is soft dust over it fine table salt, which sinks into the wax. When the plate is placed in the acid the salt dissolves away, leaving "punctures" in the wax resist.

Still a more delicate way is to oil the plate and sift powdered sulphur over it. The grains of sulphur etch the copper enough to show a grain in printing.

TO COPPER-PLATE ZINC.

When the writer began to introduce zinc etchings in New York in 1881 the printers would not receive them because they claimed they would not take ink, so the zinc was copper-faced in the following manner:

Make two solutions, one a saturated solution of copper sulphate and the other a saturated solution of cyanid of potassium. Pour the cyanid solution into the copper solution, being careful when doing so to do it out of doors and to windward of the mixture, as the fumes that result are fatal if taken into the lungs.

Scrub the surface of the zinc plate thoroughly with potash, and place this in the cyanid of copper solution, when it will almost immediately take on a perfect coating of pure copper. Remove and wash well under the tap and dry with a clean cloth.

TO PREVENT OXIDATION OF ZINC ETCHINGS.

Many printers complain that zinc engravings oxidize. This is caused by the lye used to clean the etchings after printing. Lye corrodes zinc when it does not injure type metal. Zinc etchings should be cleaned with benzin after printing from them. If they are to be put away for use a long time later they should be heated and rubbed over with wax. When the etchings are to be used the wax can be removed by again heating and cleaning with turpentine.

POINTERS FOR THE PHOTOGRAPHER,

INCLUDING

SOME STANDARD FORMULAS AND METHODS HE SHOULD KNOW.

PHOTOGRAPHING ON WOOD.

The sides of the block are rubbed with heated wax or paraffin. This is to keep moisture from injuring the wood. Three solutions are kept in stock ready for use:

1. Gelatin .....16 grains to the ounce of water
2. Nitrate of silver.....80 grains to the ounce of water
3. Citric acid .....40 grains to the ounce of water

The white of an egg is beaten to a froth and left standing over night. Now, to sensitize the wood block, take —

White of egg..... 1 dram
Gelatin solution .....¼ dram
Best zinc white.....⅛ ounce
Ammonium chlorid ..... 5 grains

Rub these into a paste in a glass mortar, and while rubbing drop slowly into the paste thirty minims of the citric acid solution and thirty minims of the nitrate of silver solution. Paint this on the block, dry in the dark and print as usual. Tone and fix if you wish, though many simply fix and wash off with hypo. Dry the moisture from the block with soft chamois. This gives a brilliant print, prevents the wood from injury by chemicals and leaves scarcely any film to interfere with the graver; all of which are appreciated by the careful wood engraver.

BLEACHING SILVER PRINTS WITH CUTTING SOLUTION.

It is not generally known that the regular "cutting" solution, a mixture of iodin, iodid of potassium and cyanid of potassium, makes a good bleaching solution for photographic prints that have been drawn with waterproof ink. Farmer's solution will also bleach them.

PLAIN PHOTOGRAPHIC PAPER—TO MAKE AND USE.

An artist can prepare his own salted photographic paper and it will keep forever if he uses this simple formula:

Water	1 ounce
Gelatin	12 grains
Chlorid of ammonium	8 grains

Take a smooth, good quality pure linen paper, if it is to be used for pen-and-ink drawing, or a rough paper, like Whatman's drawing-paper, if for washwork, and immerse it in the above solution while warm.

When the paper is soaked with this liquid hang it up to dry. It will keep indefinitely. To sensitize it, in a dark-room, swab over its surface, with a wad of absorbent cotton:

Water	1 ounce
Nitrate of silver	50 grains
Citric acid	15 grains

After printing under a negative, fix in one ounce of hyposulphit of soda in ten ounces of water and wash well.

BLEACHING PHOTOGRAPHIC PRINTS WHITE.

Clemon's matt-surface paper is sensitized by rubbing over it, with a tuft of cotton, a solution of forty grains of nitrate of silver and dried. A photographic print is made upon it and fixed in hyposulphit of soda. Washed and dried it will be found one of the finest mediums for drawing upon. After the drawing is finished it can be bleached a permanent white by flowing over it a solution of

Mercury bichlorid	1 ounce
Water	5 ounces
Alcohol	1 ounce
Hydrochloric acid	1 dram

If the drawing is made with a nonwaterproof ink, then alcohol is substituted for the water in the formula. When the bleaching solution is poured off, the drawing is washed under the tap to remove the mercury.

BLUE-PRINTS — CYANOTYPE.

The ferroprussiate paper used by architects, commonly called blue-print paper, can be prepared of a better quality than any purchasable by using the following formula:

Water	10 ounces
Gum arabic	1 ounce
Red prussiate of potash	1 ounce 20 grains
Citrate of iron and ammonia	1 ounce 20 grains

This solution can be applied to well-sized or highly calendered paper with a flat brush, but it must be dried in the dark.

TO BLEACH BLUE-PRINTS.

If waterproof ink is used to draw upon blue-prints they can be bleached white by flowing with a strong solution of saleratus or baking soda (carbonate of soda). Of course, cyanid of potassium, dilute ammonia and other alkalies will bleach blue-prints, but the saleratus is least harmful to use. Potassa solution, U. S. P. (potassium hydroxid), may also be used.

COST OF WOOD ENGRAVING.

The writer was requested by the Alumni Association of one of the leading colleges in the United States to have engraved for them in wood a portrait of their retiring president. A well-known portrait engraver was seen who measured the photograph carefully and found it was 4 by 5½ inches, an engraving of which, that size, he said would cost from $230 to $240. An engraving of the portrait enlarged to 8 by 10 inches would cost $480, and larger sizes in proportion, or $10 for each square inch. Proofs would cost $1 each, and the smaller engraving, 4 by 5½ inches, could be finished in about seven weeks. If these are the prices of wood engraving in competition with photoengraving, what would be the charges for wood engraving if methods of engraving through the aid of photography had not been discovered? With the Japanese schoolboy, "I ask to know."

BICHROMATE POISONING REMEDIES.

So many processworkers suffer from sores on their hands from bichromate poisoning that the following specifics should be known. To allay irritation use:

Alcohol (pure grain)	1 ounce
Glycerin	½ ounce
Carbolic acid (pure)	1 dram

Nitrate of mercury ointment is used to heal up the old sores. In the U. S. Pharmacopæia it is "Unguentum Hydrargii Nitratis," and is compounded as follows:

Nitrate of mercury	160 grains
Nitric acid	1 ounce
Prepared lard	1 ounce
Olive oil	3 ounces

To prepare this ointment, dissolve the mercury in the nitric acid. By the aid of gentle heat, melt the lard in the olive oil in a vessel standing in hot water. Bring the water in the outer vessel to a boil, and after heating the mercury solution to the boiling point, pour the latter into the oil, stirring all the while with a glass rod. If the mixture does not froth up at once, increase the heat until it does, and then stir until cold.

Another preventive of bichromate poisoning is to wash the hands with good castile soap after using bichromate. Dry the hands thoroughly and then rub into them a few drops of the alcohol, glycerin and carbolic solution recommended above.

VIOLET RAYS INJURE EYESIGHT.

The violet rays from the enclosed arc lamp, not being bright, are not suspected of being injurious to eyesight until the injury is done. Yellow glasses such as are used to prevent snow-blindness will protect the photographer's eyes from injury. It is the ultra violet rays in sunlight that burn the skin of the "summer girl" or the process man, but after continuing in sunlight for several days nature furnishes a coat of tan, which is, after all, but a yellow filter.

TO CARE FOR A LITHOGRAPHIC ROLLER

PROPERLY

IS A MOST IMPORTANT MATTER IN SEVERAL OF THE PHOTOMECHANICAL PROCESSES.

LITHOGRAPHIC ROLLER PREPARATION.

A good smooth-skin leather litho roller is a treasure, not only to the lithographer but to the process engraver, for laying a proper film of etching-ink on a zinc plate that has an albumen print on it.

Litho hand rollers are made of wood like the housewife's rolling pin, then they are wrapped first with several thicknesses of fine flannel and covered on the outside with calfskin. The seam in the skin should be scarcely visible when the roller is new, and after much use it will disappear entirely if the roller is properly taken care of.

To break in a new litho roller the leather must first be saturated with an oil and then with litho varnish. It is an operation that takes time. Castor oil is excellent to begin the treatment with. On a clean ink slab spread a little castor oil and roll up the roller in this several times during the day and leave it over night if possible. Next day the castor oil should be soaked into the leather. Wipe any surplus oil from the roller and roll it up in middle linseed oil varnish several times during the second day and allow the varnish to be absorbed by the roller over night. This should be repeated for several days until the leather will not absorb any more varnish.

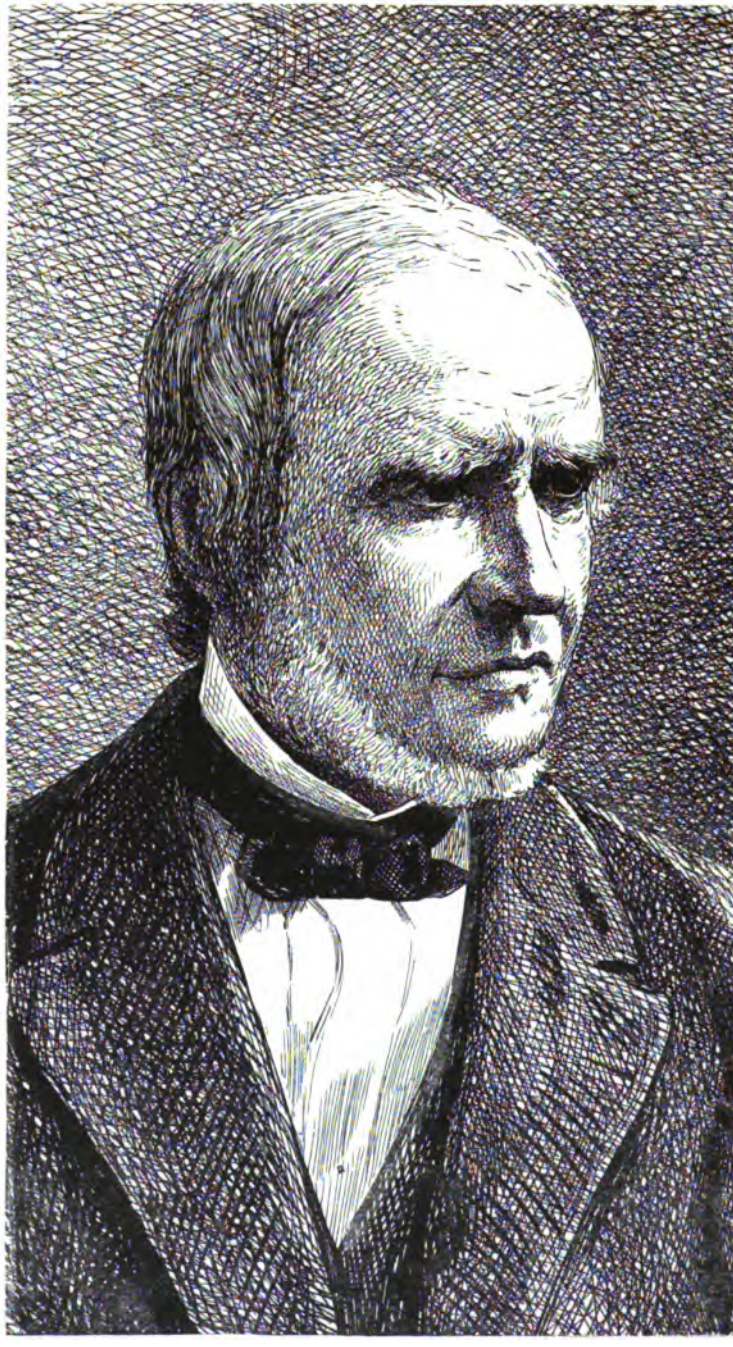
When using etching-ink on the roller, warm the ink slab, take but a little etching-ink on the end of the palette-knife and heat it before spreading it in a broad line across the ink slab. Roll this ink well into the roller, turning the latter occasionally so as to get a perfectly even coating on the slab.

The writer never used benzin, turpentine or other fluid than varnish on the roller to clean it. He merely softened

old ink on the roller with litho varnish and then with the back of a knife scraped the roller, with the grain of the skin, free of ink. Every Saturday the roller was rolled up in litho varnish and left until Monday to soften. Then it was scraped and rolled up, with either etching-ink or lithographic ink, depending on whether he was going to use it for photolithographic work or for etching-ink on zinc, and the roller was always in excellent condition. When not in use it must be kept in a box, resting on its handles, and free from dust.

PRINTING ON STONE WITHOUT A FRAME.

As the use of a printing-frame for getting a photo-print on stone, from a negative on glass, is not feasible, it is customary to strip the negative film from its glass support and bring it into contact with the sensitive coating on stone by the use of vaseline or some transparent non-drying oil that has no effect on the sensitive gelatin or albumen coating on the stone. The negative is stripped from the glass by the method described elsewhere, and the side that is to come into contact with the stone is smeared over with vaseline, glycerin, castor oil or olive oil, taking care not to form small bubbles. The film is then turned over on the sensitized and slightly warmed stone and slid into its proper place, after which a thin sheet of paper is laid over it and the surplus oil squeegeed out from between the film and stone, with a roller squeegee by preference. The oil is then cleaned from the surface of the negative film with a soft rag and benzin. After printing in sunlight, electric light (or, if a cloudy day, see that the light reaches the film at as near right angles as possible), peel the negative carefully from the stone, in the darkroom, wipe off the oil with a soft rag and benzin and then develop with water. This method can, of course, be applied to metal plates too large for the printing-frames at hand.



FROM A NEGATIVE ETCHED WITH NEEDLE POINTS.
New York *Daily Graphic*, June 26, 1873.

NEGATIVES ETCHED BY HAND.

ALSO

THE VARNISH FOR SCREEN RULING HERE USED IS A MOST VALUABLE FORMULA.

There is a little-known method of producing negatives mechanically that was practiced on the New York *Daily Graphic* from 1873 to 1876. It has some advantages for exceedingly fine engraving and for scientifically accurate work. It is here published for the first time.

Instead of drawing in waterproof ink over a photograph on plain paper, as described elsewhere, a photographic positive is made from the copy on glass, similar to a magic-lantern transparency. This positive must be the exact size of the intended reproduction of the photograph, engraving or lithograph. It is better to make this positive by the collodion process, either wet or dry, though a gelatin dry plate can be used.

A MOST VALUABLE VARNISH FORMULA.

When the positive is dry it is slightly warmed and flowed, on the film side, with the following artists' etching varnish:

A.	Powdered Egyptian asphalt.....	4 ounces
	Turpentine, U. S. P.....	20 ounces
B.	Burgundy pitch (from Norway spruce).....	1 ounce
	Turpentine, U. S. P.....	12 ounces
	Beeswax, pure 1½	ounces

It is necessary that all the ingredients of this varnish be pure and no "substitutes" used instead of them. The method of preparation is this: The four ounces of powdered asphalt is dissolved in twenty ounces of spirits of turpentine. The one ounce of Burgundy pitch is dissolved in the twelve ounces of turpentine with the aid of slight heat, and then the one and one-half ounces of pure beeswax is added. The solutions A and B are mixed, and then fil-

tered several times before using. Porcelain-lined pots are recommended for the mixing vessels and glass rods for stirring purposes.

ETCHING THE NEGATIVE.

In a warm place, free from dust, the positive is flowed with this varnish just as if it were collodion. It is allowed to dry, by the evaporation of the turpentine, in an oven or warm place, after which it is allowed to cool, when the artist will find it to be hard and a delightful medium to etch in with a needle point.

The artist is provided with a set of etchers' steel points. He places the positive in a photographers' retouching stand, large enough for him to turn the positive around in so as to use his needles in any direction. All the light comes through the positive, which he can see beautifully clear through the golden-hued transparent varnish which covers it. Should the subject be a portrait, he traces through the ground just as an artist etcher does through the etching ground on the copper plate, with the advantage that he has the portrait to guide him and there is no trouble in getting correct drawing. The points slide so easily over the smooth glass that the lines possess a grace and freedom of execution that is not possible by any other method.

ADMIRABLE FOR SCIENTIFIC WORK.

The line engraved in this manner possesses a sharpness, crispness and smoothness of edge admirably adapted for scientific work. Most accurate work can be done with these mechanically engraved negatives, for at no stage in the process is there any danger of distortion. The artist traces the positive exactly, and from this hand-made negative the print is made upon the metal direct. Furthermore, lines can be engraved of most extreme fineness, and in number to the inch so great as not to be counted without a magnifier.

VARNISH FOR SCREENMAKING.

The formula for varnish used in this process is the one used in screenmaking for coating the glass before ruling

them with a diamond point. It will be found that this varnish permits cross-ruling without chipping, so that screens for the rotary photogravure process can be made through its use. Glass so ruled may be used either at once for a screen or the glass can be etched with hydrofluoric acid, the varnish removed, and the etched lines on the glass filled in with the finest possible vine-carbon printing-ink. In making the ordinary cross-line screen it is better to rule two single-line screens and cement them to each other at right angles with Canada balsam, for the reason that in attempting to etch crossed lines in glass with hydrofluoric acid the sharp corners of the squares are rounded by the acid.

FACTS CONCERNING SCREENS.

CLEANING HALF-TONE SCREENS.

Japanese or Chinese silk, from which all the size has been removed by washing in hot water, is the best material to clean half-tone screens with. If there should be some dirt on the screen, which moistening with the breath and rubbing with the silk will not remove, it can be softened with a few drops of alcohol and rubbed with soft silver tissue-paper, followed with the silk. The cleaning should be done while the screen lies flat on a soft support. No rouge, rottenstone, whiting or other polishing powder should be used on a screen. The silk used to clean with should be kept in a tight covered box when not in use.

TO PREVENT SCREEN SWEATING.

This is one of the " bugaboos " of the half-tone negative-maker in winter if the lightroom is not of the same temperature as the darkroom. The wet collodion plate is sensitized in a warm silver bath and then placed with a cold screen in a camera in a cold lightroom for a long exposure, with the result that sweat forms on the side of the screen nearest the wet plate and the result is a fuzzy negative. The reme-

dies are many. One is to polish the screen with "La Crystaline," a medium used in cold countries to prevent sweat forming on spectacle lenses when going from out of doors to a warm interior. Polishing with wax and glycerin are also recommended. Keeping a hot water bottle in the camera box is another remedy, while the best plan of all is to keep darkroom, lightroom, silver bath and screen all at as nearly the same temperature as possible.

MEZZOGRAPH SCREEN.

Some of the points to be observed when using a mezzograph screen are the following: The screen distance is of the most importance and can be determined only by observing the mezzograph image formation on the ground glass with a powerful magnifier. A diaphragm of f/32 should be used, after the copy is focused with an open lens. With the small stop start with the screen as close to the ground glass as possible, and when the curious pattern of the screen appears sharpest, that is the proper distance. The exposure is surprisingly short. Do not overdevelop, and clear the negative of any veil or fog with the cutting solution before intensification with copper and silver. The screen distance need hardly be changed with the camera extension nor with change of stops. It is better when printing on copper to use a very thin enamel.

WHERE THE MEZZOGRAPH SCREEN IS MOST USEFUL.

The mezzograph screen is far superior to the ordinary half-tone screen when reproducing copy which is either a half-tone print, a wood engraving, or a steel engraving. Where the cross-line screen would give a pattern the mezzograph screen reproduces without pattern. For the tint plate in duotypes it is most useful, and in four-color work many firms use it for the yellow plate. In the reproduction of grained leather, or stone and landscapes, the mezzograph screen is of more service than the cross-line one.

PROCESSWORKERS MAY BE JAILED OR FINED FOR THESE REASONS.

WHEN IS A PICTURE UNFIT FOR PUBLICATION?

"This question was lately brought to a practical issue in New York, and squarely met by Stephen H. Horgan, art editor of the New York *Tribune.*" — W. I. Scanlan, *Penrose's Pictorial Annual,* 1904-05, page 71.

"The increasing use of semidraped and nude figures in the illustration of advertisements, booklets, and other publicity matter brings up a point which is of practical interest to photographers everywhere. The question, What makes a photograph unfit for publication? is not always easily decided; but upon its decision often a fine of $5,000 may depend. In *The Inland Printer* for June (1904) Mr. Stephen H. Horgan, the art editor of the New York *Tribune,* answers this question so tersely and so much to the point, that its publication may serve to keep some photographer out of trouble." — John A. Tennant, editor, *Photo-Miniature.*

"This question has long demanded an answer, and one which, with the increasing use of photography in all sorts and kinds of advertising matter, is becoming more important every day. We gladly give space in this journal to Mr. Horgan's rule governing the subject, believing it to be in the best interest of all that is best in photography." — *Wilson's Photographic Magazine.*

The rule, printed first in *The Inland Printer,* was as follows:

"Photographs of human beings in costumes or poses in which they would not appear in public are liable to be unfit for publication in an ordinary newspaper."

"This seems about as reasonable a definition of what makes a picture unfit for publication as we are likely to get." — *British Journal of Photography.*

Section 3893 of the Revised Statutes of the United

States forbids the mailing of a publication containing an indecent picture and fixes the penalty, upon conviction, of $5,000 fine, or five years at hard labor, or both.

GOVERNMENT MONEY OR STAMPS MUST NOT BE PHOTOGRAPHED.

All processworkers should know that the present law makes it a crime to photograph even a portion of any stamp, bill or certificate of the United States or any other country. The crime is punishable with heavy fines and punishment for a long term of years. By an addition to the law, approved February 10, 1901, "Every person who has in possession any business card, notice, device, print or impression, or any other thing whatsoever, whether of metal or any other thing whatsoever, in likeness or similitude, as to design, color, or the description thereon, of any of the coins of the United States, or any foreign government, shall, upon conviction thereof, be punished by a fine not to exceed $100." It will be seen by this that the reproduction of new postage stamps is forbidden and also the drawing of bills or coins in a cartoon.

COPYRIGHT LAW PENALTIES.

Every processworker should know that Section 25 of the copyright law thus specifies the fines which may be imposed for the reproduction of a copyrighted object without permission:

"In the case of a painting, statue, or sculpture, $10 for every infringing copy found in the possession of the infringer or his agents or employees. In the case of any other object reproduced the penalty is $1 for every infringing copy made or sold by or found in the possession of the infringer or his agents or employees. In the case of a newspaper reproduction of a copyrighted photograph the damages shall not exceed the sum of $200 or be less than $50, and in no other case exceed the sum of $5,000 nor be less than the sum of $250."

Full costs are added in every case to damages.

DIRECT PROCESS WITH NORWICH FILM.
Ozias Dodge, Norwich, Conn.

THE "DIRECT PROCESS" WITH NORWICH FILM.

This process was the outcome of experiments carried on by Ozias Dodge, the painter-etcher, of Norwich, Connecticut. As at first practiced it consisted of a grained transparent sheet on which an original drawing was executed with an ordinary pencil. This sheet was subsequently flowed with collodion to protect the drawing. From this positive drawing on its transparent support a negative print was obtained on a sensitized copper plate which was etched intaglio. The impression from this intaglio plate was an exact reproduction of the pencil drawing.

Later Mr. Dodge devised a method of making relief plates from the drawing on the transparent sheet, all of his processes being covered by patents in this and other countries. In his relief-plate method the picture is drawn with a pencil or ink that is soluble in gasoline or similar solvent. Or, the picture may be printed in a lithographic ink on his transparent sheet known as the "Norwich Film." The "Norwich Film" containing the picture is next covered with a red and yellow varnish. This varnish is so arranged hygroscopically that it will penetrate the sheet to a certain depth in proportion to the density of the image. The next step is to develop a negative image in the red and yellow varnish. This is done with gasoline, which removes every particle of the original drawing or impression, leaving the varnish transparent only where the image was, and thus produces a perfect negative of the original drawing or impression. This negative can be used for any purpose in processwork.

The process is especially useful in making up tint-blocks from a key-plate. The material being highly transparent, it is easy to obtain register when making color plates. Further, the transparent material is so thin that negatives made on it can be printed from either side, which supplies the reversed negative required for the offset press.

TO PHOTOGRAPH KEY-PLATES ON ZINC.

There are two ways of photographing a drawing on plain zinc so as to leave only a stain on the metal, that tints in ink can be laid for color plates, or an artist can stipple the tints on the metal.

One method shows the image in bright polished zinc on a gray ground and the other gives a black image with a gray ground. The first one is more frequently used.

In both cases an inked albumen print is made on the zinc as described in "Line Etching." In the first method the inked albumen print is made on a polished sheet of zinc, dusted with resin and heated slightly; then it is put into a graining bath and given a beautiful gray matt surface everywhere but where the ink image is. When the gray background is right, wash the plate under the tap, dry and clean off the inked image with potash, when the print on zinc will be seen dark polished zinc on a gray ground.

With the other method the zinc is cleaned thoroughly and brushed over with chlorid of antimony — butter of antimony it is commonly called. This turns the zinc a beautiful blue-black. The zinc is then washed and dried and an inked albumen print made upon it. This is resined and heated, as before, after which it is rocked in the graining bath. This bath clears away the black stain from the zinc, leaving a gray in its place, and when the inked image is cleared off with potash it will be seen black against a gray ground.

WEIGHTS OF SHEET METALS PER SQUARE FOOT.

The approximate weight of the sheet metals used in engraving are as follows, the gauge being Stubbs': 14-gauge zinc weighs 45 ounces per square foot; 15-gauge, 43 ounces, and 16-gauge, 39 ounces.

Copper, 14-gauge, weighs 64 ounces a square foot; 15-gauge weighs 56 ounces, and 16-gauge, 48 ounces.

Brass, 12-gauge, weighs 66 ounces a square foot; 14-gauge weighs 60 ounces; 15-gauge weighs 53 ounces; 16-gauge, 45 ounces, and 17-gauge, 40 ounces.

UNITED STATES WEIGHTS AND MEASURES.

APOTHECARIES' WEIGHT.

Usually adopted in formulas.

20 grains	= 1 scruple	=	20 grains
3 scruples	= 1 dram	=	60 grains
8 drams	= 1 ounce	=	480 grains
12 ounces	= 1 pound	=	5,760 grains

FLUID MEASURE.

60 minims	= 1	fluid dram
8 drams	= 1	fluid ounce
16 ounces	= 1	pint
8 pints	= 1	gallon

APOTHECARIES' WEIGHT.

Pound.		Ounces.		Drams.		Scruples.		Grains.		Grams.
1	=	12	=	96	=	288	=	5,760	=	373.24
		1	=	8	=	24	=	480	=	31.10
				1	=	3	=	60	=	3.89
						1	=	20	=	1.30
								1	=	.06

The pound, ounce and grain are the same as in troy weight.

AVOIRDUPOIS WEIGHT.

By which all chemicals are usually sold.

27 11/32 grains	= 1 dram	=	27 11/32 grains
16 drams	= 1 ounce	=	437½ grains
16 ounces	= 1 pound	=	7,000 grains

AVOIRDUPOIS WEIGHT.

Pound.		Ounces.		Drams.		Grains (Troy).		Grams.
1	=	16	=	256	=	7,000	=	453.60
		1	=	16	=	437.5	=	28.35
				1	=	27.34	=	1.77

UNITED STATES FLUID MEASURE.

Gal.		Pts.		Ozs.		Drams.		Mins.		Cub. In.		Grains.		Cub. C. M.
1	=	8	=	128	=	1,024	=	61,440	=	231.	=	58,328.886	=	3,785.44
	1	=		16	=	128	=	7,680	=	28.875	=	7,291.1107	=	473.18
		1	=			8	=	480	=	1.8047	=	455.6944	=	29.57
				1	=			60	=	0.2256	=	56.9618	=	3.70

VOLUME — LIQUID.

4 gills = 1 pint.
2 pints = 1 quart.
4 quarts = 1 gallon.

Gills.		Pints.		Gallon.		Cub. In.
32	=	8	=	1	=	231

TROY WEIGHT.

Pound.		Ounces.		Pennyweights.		Grains.		Grams.
1	=	12	=	240	=	5,760	=	373.24
		1	=	20	=	480	=	31.10
				1	=	24	=	1.56

THE CONVERSION OF FRENCH (METRIC) INTO ENGLISH MEASURE.

1	cubic centimeter	=	17	minims.				
2	cubic centimeters	=	34	minims.				
3	cubic centimeters	=	51	minims.				
4	cubic centimeters	=	68	minims or	1	dram	8	minims.
5	cubic centimeters	=	85	minims or	1	dram	25	minims.
6	cubic centimeters	=	101	minims or	1	dram	41	minims.
7	cubic centimeters	=	118	minims or	1	dram	58	minims.
8	cubic centimeters	=	135	minims or	2	drams	15	minims.
9	cubic centimeters	=	152	minims or	2	drams	32	minims.
10	cubic centimeters	=	169	minims or	2	drams	49	minims.
20	cubic centimeters	=	338	minims or	5	drams	38	minims.
30	cubic centimeters	=	507	minims or	1	ounce	0 dram	27 minims
40	cubic centimeters	=	676	minims or	1	ounce	3 drams	16 minims
50	cubic centimeters	=	845	minims or	1	ounce	6 drams	5 minims
60	cubic centimeters	=	1014	minims or	2	ounces	0 dram	54 minims
70	cubic centimeters	=	1183	minims or	2	ounces	3 drams	43 minims
80	cubic centimeters	=	1352	minims or	2	ounces	6 drams	32 minims
90	cubic centimeters	=	1521	minims or	3	ounces	1 dram	21 minims
100	cubic centimeters	=	1690	minims or	3	ounces	4 drams	10 minims
1000	cubic centimeters	=	1 liter = 34 fluid ounces nearly, or 2⅛ pints					

THE CONVERSION OF FRENCH (METRIC) INTO ENGLISH WEIGHT.

1	gram	=	15⅜	grains.				
2	grams	=	30⅞	grains.				
3	grams	=	46⅜	grains.				
4	grams	=	61⅞	grains.....	or	1 dram	1⅞	grains.
5	grams	=	77⅜	grains.....	or	1 dram	17⅜	grains.
6	grams	=	92⅞	grains.....	or	1 dram	32⅞	grains.
7	grams	=	108	grains.....	or	1 dram	48	grains.
8	grams	=	123⅜	grains.....	or	2 drams	3⅜	grains.
9	grams	=	138⅞	grains.....	or	2 drams	18⅞	grains.
10	grams	=	154⅜	grains.....	or	2 drams	34⅜	grains.
11	grams	=	169⅞	grains.....	or	2 drams	49⅞	grains.
12	grams	=	185⅜	grains.....	or	3 drams	5⅜	grains.
13	grams	=	200⅞	grains.....	or	3 drams	20⅞	grains.
14	grams	=	216	grains.....	or	3 drams	36	grains.
15	grams	=	231⅜	grains.....	or	3 drams	51⅜	grains.
16	grams	=	247	grains.....	or	4 drams	7	grains.
17	grams	=	262⅜	grains.....	or	4 drams	22⅜	grains.
18	grams	=	277⅞	grains.....	or	4 drams	37⅞	grains.
19	grams	=	293⅜	grains.....	or	4 drams	53⅜	grains.
20	grams	=	308⅞	grains.....	or	5 drams	8⅞	grains.
30	grams	=	463	grains.....	or	7 drams	43	grains.
40	grams	=	617⅞	grains.....	or	10 drams	17⅞	grains.
50	grams	=	771⅜	grains.....	or	12 drams	51⅜	grains.
60	grams	=	926	grains.....	or	15 drams	26	grains.
70	grams	=	1080⅜	grains.....	or	18 drams	0⅜	grains.
80	grams	=	1234⅞	grains.....	or	20 drams	34⅞	grains.
90	grams	=	1389	grains.....	or	23 drams	9	grains.
100	grams	=	1543⅜	grains.....	or	25 drams	43⅜	grains.
1000	grams	=	1 kilogram = 32 oz., 1 dr., 12⅜ gr.					

TABLE SHOWING THE COMPARISON OF THE READINGS OF THERMOMETERS.

Fahrenheit	Celcius Centigrade	Réaumur	Fahrenheit	Celcius Centigrade	Réaumer
—22.0	—30	—24.0	73.4	23	18.4
—13.0	—25	—20.0	75.2	24	19.2
— 4.0	—20	—16.0	77.0	25	20.0
+ 5.0	—15	—12.0	78.8	26	20.8
14.0	—10	— 8.0	80.6	27	21.6
23.0	— 5	— 4.0	82.4	28	22.4
24.8	— 4	— 3.2	84.2	29	23.2
26.6	— 3	— 2.4	86.0	30	24.0
28.4	— 2	— 1.6	87.8	31	24.8
30.2	— 1	— 0.8	89.6	32	25.6
			91.4	33	26.4
Freezing point of water.			93.2	34	27.2
			95.0	35	28.0
32.0	0	0.0	96.8	36	28.8
33.8	1	0.8	98.6	37	29.6
35.6	2	1.6	100.4	38	30.4
37.4	3	2.4	102.2	39	31.2
39.2	4	3.2	104.0	40	32.0
41.0	5	4.0	105.8	41	32.8
42.8	6	4.8	107.6	42	33.6
44.6	7	5.6	109.4	43	34.4
46.4	8	6.4	111.2	44	35.2
48.2	9	7.2	113.0	45	36.0
50.0	10	8.0	122.0	50	40.0
51.8	11	8.8	131.0	55	44.0
53.6	12	9.6	140.0	60	48.0
55.4	13	10.4	149.0	65	52.0
57.2	14	11.2	158.0	70	56.0
59.0	15	12.0	167.0	75	60.0
60.8	16	12.8	176.0	80	64.0
62.6	17	13.6	185.0	85	68.0
64.4	18	14.4	194.0	90	72.0
66.2	19	15.2	203.0	95	76.0
68.0	20	16.0	212.0	100	80.0
69.8	21	16.8			
71.6	22	17.6	Boiling point of water.		

POISONS, SYMPTOMS AND ANTIDOTES.

Many of the chemicals used in processwork are poisonous, either when taken internally or if absorbed through cuts or abrasions in the skin. In every suspicious case of poisoning a medical man should be at once sent for. But, pending his arrival, the following remedies may be applied. No time should be lost. Vomiting should be brought on at once by tickling the throat with a small brush or thrusting the fingers down the throat as far as possible. Three or four tumblers of warm mustard water usually acts as an emetic. If it does not act in fifteen minutes, repeat it:

POISONS.	SYMPTOMS AND EFFECTS.	ANTIDOTES.
Acetic acid.	Corrosion of windpipe, pain in abdomen, perhaps convulsions, collapse and death.	Large draughts of soap and water to be taken at once. Stomach-pump not to be used. Magnesia, chalk and water, lime-water, or whitewash and water.
Nitric acid. Hydrochloric (muriatic) acid. Sulphuric acid. Or mineral acids.	Hot, burning pains in the throat and stomach, lips burned and shriveled, excessive thirst, drink increasing the pain.	Mix at once chalk and water or soap and water. No time must be lost. If necessary, scrape the lime plaster from the walls, make into a thin paste and give a wineglassful every two minutes. Encourage vomiting by drinking warm water.
Alcohol. Wood alcohol. Denatured alcohol.	Drunkenness, coma, death.	Stomach-pump or emetics; mustard in water; keep patient awake and on the move by pinching, shaking and walking him about.
Ammonia.	Burning sensation in the mouth, chest, throat and stomach; lips and tongue swollen, suffocation. Inhaling ammonia will cause violent irritation of the larynx.	Vinegar, freely diluted with water; acetic or any other acid diluted with large quantities of water; lemon or orange juice. If unable to swallow, inhalation of acetic acid or vinegar from saturated pocket handkerchief.
Benzin.	Vapor acts as narcotic; noises in the head, convulsive tremblings, difficulty in breathing.	Brandy, ½ dram liquor ammonia in glass of water, frequently repeated; inhalation of ammonia; hot and cold douches.
Copper sulphate.	Metallic taste, constriction in throat, griping pains in abdomen, headache, giddiness, coma, death.	Stomach-pump, egg-albumen, milk, milk and eggs, or emetic — warm water and mustard.
Ether.	Stupefaction.	Loosen everything about the chest, open doors and windows for fresh air, alternate cold and warm douches.

POISONS.	SYMPTOMS AND EFFECTS.	ANTIDOTES.
Iodin.	Pain and heat in throat and stomach, with vomiting, giddiness, convulsions, death.	Stomach-pump, emetic — mustard and water, egg, albumen and water.
Lead nitrate.	Cramps, cold sweat, convulsions.	Stomach-pump, emetic of mustard and water.
Mercury bichlorid.	Three grains fatal dose. Burning in the throat and stomach, nausea, lips and mouth white and swollen, feeble pulse and cold skin.	Whites of six or eight eggs beaten up in ten ounces of water; give wineglassful every two minutes, or milk and barley water, to ease the vomiting.
Bichromate potassium or ammonia.	Powerful poison. Acute pains in abdomen, violent vomiting, pupils dilated.	Stomach-pump or emetic, carbonate of magnesia, or chalk in milk, white of egg in milk or water, warmth to extremities and give stimulants freely.
Cyanid potassium.	Three grains fatal. Violent poison. Produces burning pain in stomach, foaming at the mouth, insensibility, convulsions, stiffness of jaws and body, death.	Stomach-pump or emetic, large drinks of sulphate of iron and water at once, ammonia or smelling-salts, inhalation of ammonia.
Silver nitrate.	Powerful irritant. Contraction of throat sometimes, while flaky matter vomited turns black on exposure to air.	Copious drinks of common salt and water, white of egg, emetic of mustard.
Potash caustic.	Heat and burning in the throat, extending to the stomach.	Give copious drinks of water containing vinegar, acetic acid, citric acid, or lemon or orange juice.

LIST OF CHEMICALS USED IN PROCESS-WORK, WITH ENGLISH, LATIN, GERMAN AND FRENCH NAMES.

ENGLISH.	LATIN.	GERMAN.	FRENCH.
Acid, acetic	Acidum aceticum	Essigsäure	Acide acetique
Acid, acetic, glacial	Acidum aceticum glaciale	Eisessig	Vinaigre glacial
Acid, chromic	Acidum chromicum	Chromsäure	Acide Chromique
Acid, citric	Acidum citricum	Citronensäure	Acide citrique
Acid, hydrochloric (muriatic)	Acidum hydrochloricum	Salzsäure	Acide chlorhydrique
Acid, nitric	Acidum nitricum	Salpetersäure	Acide nitrique (azotique)
Acid, pyrogallic, pyrogallol	Acidum pyrogallicum	Pyrogallussäure, Pyrogallol	Acide pyrogallique
Acid, tartaric	Acidum tartaricum	Weinsteinsäure	Acide tartarique
Acid, sulphuric	Acidum sulphuricum	Schwefelsäure	Acide sulfurique
Acid, tannic, tannin	Acidum tannicum	Gerbsäure	Acide tannique
Alcohol, ethyl	Alcohol	Weingeist	Alcool
Alcohol, wood	Alcohol methylicum	Holzgeist	Alcool methylique
Alum, chrome	Chromii et potassi sulphas	Chrom-alaun	Alun chromi-potassique
Alum, potassa	Aluminii et potassi sulphas	Kali-alaun	Sulfate d'alumine et de potasse
Ammonium bichromate	Ammonii bichromicum	Doppeltchromsaures ammon	Bichromate d'ammoniaque
Ammonium, iodid	Ammonii iodidum	Ammoniumiodid	Iodure d'ammonium
Benzin	Benzinum	Petroleumbenzin	Benzine
Benzol	Benzolum	Benzol	Benzole
Cadmium, bromid	Cadmii bromidum	Kadmium bromid, bromkadmium	Bromure de cadmium
Cadmium, iodid	Cadmii iodidum	Kadmiumjodid, jodkadmium	Iodure de cadmium
Collodion	Collodium	Collodion	Collodion
Copper, metal	Cuprum	Kupfer	Cuivre
Copper, sulphate	Cupri sulphas	Kupfersulfat	Sulfate de cuivre
Dextrin	Dextrinum	Stärkegummi	Dextrine
Ether (sulphuric)	Aether (sulphuricus)	Aether, schwefeläther	Ether sulfurique
Gelatin	Gelatina	Gelatin	Gelatine
Glycerin	Glycerinum	Glycerin	Glycerine
Glycin	Glycinum	Glycin	Glycine
Gum arabic	Gummiarabicum	Arabisches gummi	Gomme arabique
Gum sandarac	Sandarac	Sandarak	Sandaraque
Gum shellac	Ressina lacca	Lack gummilack	Laque
Hydrochinon	Hydrochinonum	Hydrochinon	Hydrochinon
Iodin	Iodum, iodidium	Jod	Iode
Iron (metal)	Ferrum	Eisen	Fer

ENGLISH.	LATIN.	GERMAN.	FRENCH.
Iron, chlorid (ferrous) (*ferro chlorid*)	Ferro chloridum	Eisenchlorür (*ferrochlorid*)	Chlorure de fer (*Chlorure ferreux*)
Iron, chlorid (ferric) (*ferric chlorid*)	Ferri chloridum (*Ferri-sesquichloridum*)	Eisenchlorid (*ferrichlorid*)	Perchlorure de fer
Iron, sulphate	Ferri sulphas	Ferrosulfat	Sulfate de fer
Lead (metal)	Plumbum	Blei	Plomb
Lead nitrate	Plumbi nitras	Bleinitrat	Nitrate de plomb
Mercury bichlorid	Hydrargyri bichloridum	Aetzendes queck-silber-chlorid	Deutochlorure de mercure
Oil of lavender	Oleum lavandulæ	Lavendelöl	Essence de lavand
Oil of turpentine	Oleum terbinthinæ	Terpintinöl	Essence terbinthine
Potassium bichromate	Potassii bichromas	Kaliumbichromat	Bichromate de potasse
Potassium cyanid	Potassii cyanidum	Cyankalium	Cyanure de potassium
Potassium (caustic potash) hydrate potassa	Potassii hydras; potassa	Aetzkali	Potasse caustique
Potassium iodid	Potassii iodidum	Jodkalium	Iodure de potassium
Potassium permanganate	Potassii permanganas	Kaliumpermanganate	Permanganate de potasse
Pyroxylin, gun-cotton	Pyroxylinum	Collodionwolle, schiess-baumwolle	Pyroxyle, fulmi-coton
Silver	Argentum	Silber	Argent
Silver chlorid	Argenti chloridum	Silberchlorid	Chlorure d'argent
Silver iodid	Argenti iodidum	Silberiodid	Iodure d'argent
Silver nitrate	Argentinitras	Silbernitrat	Nitrate d'argent
Sodium bicarbonate	Sodii bicarbonas	Natriumbicarbonat	Bicarbonate de soude
Sodium carbonate	Sodii carbonas	Natriumcarbonat	Carbonate de soude
Sodium hyposulphit or thiosulphate	Sodii hyposulphis	Unterschwefligsaures natron	Hyposulfite de soude
Starch	Amylum	Stärke, städkmehl	Amidon
Strontium chlorid	Strontii chlordum	Chlorstrontium	Chlorure de strontium
Turpentine, crude or white	Terebinthina communis	Geweiner terpentin	Terebenthine commune
Water, distilled	Aqua destillata	Destillirtes-wasser	Eau distillée
Water of ammonia	Aqua ammoniæ	Salmiakgeist, ammoniak-flussigkeit	Eau d'ammoniaque

TABLE OF SYMBOLS OF THE PRINCIPAL CHEMICALS USED IN PROCESSWORK.

NAME.	SYMBOL.
Acid, Acetic	$C_2H_4O_2$.
Acid, Hydrochloric	HCl+7H2O.
Acid, Nitric	HNO_3.
Acid, Sulphuric	H_2SO_4.
Alcohol, Ethyl	C_2H_6O.
Alcohol, Methyl (Wood Alcohol)	CH_4O.
Alum (Potassium Aluminum Sulphate)	$Al_2(SO_4)_3K_2SO_4+24H_2O$.
Alum Chrome (Potassium Chromic Sulphate)	$Cr_2(SO_4)_3K_2SO_4+24H_2O$.
Ammonia, Gaseous	NH_3
Ammonium Bichromate	$(NH_4)_2Cr_2O_7$.
Ammonium, Bromid	NH_4Br.
Ammonium, Iodid	NH_4I.
Benzol or Benzin (Trioxy-triphenyl-Carbinol)	C_6H_6.
Cadmium Bromid	$CdBr_2+4H_2O$.
Cadmium Iodid	CDI_2.
Caustic Potash (Potassium Hydrate)	KOH.
Caustic Soda (Sodium Hydrate)	NaHO.
Copper Sulphate	$CuSO_45H_2O$.
Gelatin, Glutin	Unobtainable.
Glycerin	$C_3H_8O_3$.
Glycin (Oxy-phenylglycin)	$C_8H_9O_3N$.
Gold, Neutral Chlorid	$AuCl_3$.
Guncotton (Tetra-nitrate Cellulose)	$C_{12}H_{16}O_6(NO_3)_4$.
Guncotton (Tri-nitrate Cellulose)	$C_{18}H_{17}O_7(NO_3)_3$.
Hydrochinon	$C_6H_6O_2$.
Hydroxylamin Hydrochlorate	NH_3OHCl.
Iodin	I.
Iron Sulphate (Ferric)	$Fe_2(SO_4)_3+9H_2O$.
Iron Sulphate (Ferrous)	$FeSO_4+7H_2O$.
Lead Nitrate	$Pb(NO_3)_2$.
Mercury, Chlorid (Mercuric) (Corros. Subl.)	$HgCl_2$.
Mercury, Chlorid (Mercurous) (Calomel)	Hg_2Cl.
Potassium, Bichromate	$K_2Cr_2O_7$.
Potassium, Cyanid	KCy or (CN).
Potassium, Ferricyanid (Red Prussiate)	K_3FeCy_6.
Potassium, Ferrocyanid (Yellow Prussiate)	$K_4FeCy_6+3H_2O$.
Potassium, Iodid	KI.
Silver, Bromid	AgBr.
Silver, Chlorid	AgCl.
Silver, Iodid	AgI.
Silver, Nitrate	$AgNO_3$.
Silver, Oxid	Ag_2O.
Water	H_2O.
Zinc, Nitrate	$Zn(NO_3)_26H_2O$.

SOLUBILITIES OF THE PRINCIPAL CHEMICALS USED IN PROCESSWORK.

Abbreviations.—s. soluble; v.s., very soluble; sp.s., sparingly soluble; n.s., not soluble; dec., decomposed; del., deliquescent; in all pro., in all proportions.

Name.	One part is soluble in cold water.	One part is soluble in hot water.	Alcohol.
Acid, Acetic	s. in all pro.		n. s.
Acid, Hydrochloric	s.	s.	s.
Acid, Nitric	s. in all pro.		n. s.
Acid, Sulphuric	s. in all pro.		n. s.
Alcohol, Ethyl	s. in all pro.		n. s.
Alcohol, Methyl (Wood Alcohol)	s. in all pro.		n. s.
Alum (Potassium Aluminum Sulphate)	10	8	n. s.
Alum Chrome (Potassium Chromic Sulphate)	10	dec.	n. s.
Ammonia, Gaseous	very soluble		.....
Ammonium Bichromate	v. s.	v. s.	.....
Ammonium, Bromid	1.29	0.7	31.5
Ammonium, Iodid	1	0.5	s.
Benzol or Benzin (Trioxy-tripheny-Carbinol)	n. s.	n. s.	s.
Cadmium Bromid	1.5	1	sp. s.
Cadmium Iodid	1.5	1	s.
Caustic Potash (Potassium Hydrate)	.5	.25	sp. s.
Caustic Soda (Sodium Hydrate)	1.5	.5	sp. s.
Copper Sulphate	3	1	n. s.
Gelatin, Glutin	sp. s.	e. s.	n. s.
Glycerin	s. in all pro.		n. s.
Gold, Neutral Chlorid	1	5	also in ether.
Guncotton (Tetra-nitrate Cellulose)	n. s.	n. s.	in ether
Guncotton (Tri-nitrate Cellulose)	n. s.	n. s.	alcohol.
Hydroxylamin Hydrochlorate	0.6	e. s.	4
Iodin	sp. s.	sp. s.	e. s.
Iron Sulphate (Ferric)	s.	dec.	s.
Iron Sulphate (Ferrous)	1.5	1	n. s.
Lead Nitrate	7.7	7	s.
Mercury, Chlorid (Mercuric) (Corros. Subl.)	19	3	5
Potassium, Bichromate	10	7	n. s.
Potassium, Cyanid	1	.5	sp. s.
Potassium, Ferricyanid (Red Prussiate)	2.5	1.2	n. s.
Potassium, Ferrocyanid (Yellow Prussiate)	3	1	n. s.
Potassium, Iodid	.75	.5	1 in 16
Silver, Bromid	n. s.	n. s.	in HCl and HBr. ammonia.
Silver, Chlorid	n. s.	n. s.	cyan. potass. hyposulphit of soda.
Silver, Iodid	n. s.	n. s.	same as chlorid.
Silver, Nitrate	1	.5	sp. s.
Silver, Oxid	n. s.	n. s.	n. s.
Zinc, Nitrate	del.	del.	del.

TABLE SHOWING HOW PERIOD OF EXPOSURE

IS AFFECTED

BY THE CAMERA EXTENSION AND BY STOP APERTURE.

This table, taken from "Penrose's Year Book" for 1896, teaches how the period of exposure must increase with the distance of the ground glass from the stop aperture, and as the size of the aperture in the diaphragm increases the time of exposure must be lessened.

Focus.	1/8 In.	1/16 In.	1/4 In.	3/8 In.	1/2 In.	5/8 In.	3/4 In.	7/8 In.	1 In.
10	67	30	17	7½	4	3	2	1½	1
11	81	36	20	9	5	3½	2½	1¾	1¼
12	96	43	24	10½	6	4	2¾	2	1½
13	113	50	28	12½	7	4½	3	2¼	1¾
14	131	58	33	14½	8	5¼	3½	2½	2
15	150	66	38	16½	9½	6	4¼	3	2½
16	171	76	43	19	10¾	6¾	4¾	3½	2¾
17	193	86	48	21½	12	7¾	5¼	4	3
18	216	96	54	24	13½	8½	6	4½	3½
19	241	107	60	27	15	9½	6¾	5	3¾
20	267	119	67	30	16½	10½	7½	5½	4
22	323	143	81	36	20	13	9	6¾	5
24	384	171	96	43	24	15½	10¾	7¾	6
26	451	200	113	50	28	18	12½	9¼	7
28	523	232	131	58	32½	21	14½	10¾	8¼
30	600	267	150	67	37½	24	16	12¼	9½
32	683	303	171	76	42½	27½	19	14	10¾
34	771	343	193	86	48	31	21½	15¾	12
36	864	384	216	96	54	34½	24	17½	13½
38	963	428	241	107	60	38½	26¾	19½	15
40	.....	474	267	119	67	42½	29¾	21¼	16½
42	.....	523	294	131	74	47	32½	24	18½
44	.....	574	323	143	81	52	36	26½	20
46	.....	627	352	157	88	56	39	28¾	22
48	.....	683	384	171	96	62	43	31½	24
50	.....	741	417	185	104	67	46	34	26

The numbers in the first left-hand column are the distances in inches from the stop to the ground glass. The fractions up to 1 inch, on the top line, are the diameters of the opening in the stop. The remaining numbers in the table are the comparative periods of exposure required in seconds.

THE PROCESSWORKERS' GLOSSARY.

AN ENDEAVOR

TO STANDARDIZE MOST OF THE TERMS COMMONLY USED IN A NEW AND CONSTANTLY CHANGING BUSINESS.

BY S. H. HORGAN.

ACHROMATIC — Without color. A lens which brings the actinic and the visual focus to the same point.

ACID — A chemical used to corrode or etch metal plates.

ACROGRAPHY — Engraving in a chalk coating on metal or stone.

ACTINIC — The property in light which produces chemical changes.

ACTINOMETER — Instrument for measuring the intensity of light.

ACTION — Used to express operation of light or chemicals.

AEROGRAPH — Name given to an air-brush.

AFFICHE — French for poster.

AIR-BRUSH — Atomizer used for the distribution of liquid color.

AKROGRAPH — Machine for producing engravings, invented by N. S. Amstutz.

ALBERTYPE — Method of printing in ink from gelatin. A collotype process invented by Joseph Albert.

ALBUMEN — The white of an egg. ALBUMIN — The chemical term.

ALGRAPHY — Planography, where aluminum plates are used instead of zinc.

ALKALI — That which will neutralize an acid. With oil it forms soap.

AMPHITYPE — Process invented by Sir John Herschel, which gives either a positive or negative.

ANAGLYPH — Stereoscopic picture invented by Ducos du Hauron, printed in red and blue and viewed through red and blue glasses.

ANAGLYPTOGRAPH — Instrument for engraving medallions in relief printing-blocks.

ANASTATIC — A method of transferring printed matter after softening the ink.

ANASTIGMAT — A lens corrected for astigmatism.

ANCHORED — Plates secured to blocks by pouring molten metal through holes bored through the back of the blocks.

APLANATIC — A lens corrected for spherical aberration.

APOCHROMATIC LENS — One corrected for chromatic and spherical aberration. A proper lens for colorwork.

ARGENTOMETER — Hydrometer for testing silver solutions.

ARTOTYPE — A collotype process improved by Obernetter.

ASPHALTUM — Also called asphalt, bitumen, bitumen of Judea and mineral pitch. That portion which dissolves in chloroform is most sensitive to light.

ASSER PROCESS — Early photolithographic process named after the inventor, in which starch was used instead of gelatin.

ASTIGMATISM — A defect in lenses which prevents the same degree of sharpness at the edges of the image as in the center. It is cured to some extent by the use of diaphragms.

ATOMIZER — Instrument for spreading liquids on fragile surfaces.

AUTOGRAPHIC PROCESS — One in which the writing or drawing becomes the printing surface.

AUTOTYPOGRAPHY — Any process by which drawings can be transferred direct to a metal plate and impressions taken.

BACKGROUND — That portion of a picture that can be removed without injury to the principal object.

BACKING-WOOD — A term for the hard wood used in blocking metal plates.

BAKE — To harden enamel by heat on metal plates.

BATH — General term given to solutions in which plates or papers are immersed or floated. Also for the vessel holding such solution.

BAUME' HYDROMETER — Instrument for determining relative densities of solutions.

BEN DAY — Method of laying tints named after the inventor.

BICHROMATIZED GELATIN — Gelatin sensitized with a bichromate salt.

BICHROMATIZE — To treat with a bichromate and make sensitive to light.

BITE — Submitting a metal plate to the action of acid.

BITUMEN PROCESS — Invented by Joseph Nicéphore Niepce in 1813. The first photoengraving process.

BLACK-AND-WHITE — Common name for pen-and-ink drawing.

BLACK LINE — A style of wood engraving in which the engraver cut around the artist's lines.

BLEACHING OUT — Either removing color or changing it to white, as in intensification.

BLOCK — Name given to any type-high printing plate.

BLOCKING — Mounting metal plates to make them type-high.

BLOCKING GAUGE — An instrument for keeping color plates in register while blocking.

BLOCKING HAMMER — Used in blocking plates.

BLOCKING NAILS — Steel wire nails with flat heads for securing plates to their blocks.

BLUE-PRINTS — Same as cyanotype. Invented by Sir John Her-

schell. Made of ferroprussiate paper and named from the color of the picture.

BOOK-PLATE — Engraved plate for printing labels to denote ownership in a book.

BOXWOOD — A yellowish, close-grained wood used by wood-engravers.

BRAYER — A small hand ink-roller.

BRISTOL-BOARD — Cardboard with a hard, smooth finish, used for pen-and-ink drawings.

BRUSH — An instrument for and act of cleaning a plate.

BUNGED UP — A shop expression for filled-up lines or dots in a negative.

BUR — A rough edge of metal neglected by the engraver.

BURIN — An engraver's tool with a lozenge-shaped point.

BURNING-IN — Heating the enamel coating on a metal plate until it carbonizes and becomes acid-resistant.

BURNISH — Rubbing on a plate to make it print darker, if a relief plate, and lighter, if an intaglio plate.

BURNISHER — An instrument of tempered steel for polishing a plate.

CALIPERS — A tool for marking on the back of a metal plate the location of defects on its face.

CALLIGRAPHIC ETCHING — A design is made on a metal plate with an ink soluble in water. The whole is covered with a thin varnish of asphalt, dragon's-blood or shellac, then soaked in a slightly alkaline water until the ink softens and can be washed away, carrying the overlying varnish. The plate is then etched intaglio.

CAMERA — The pattern of camera obscura used in photography.

CAMERA LUCIDA — An arrangement of a prism used by artists in copying objects.

CAMERA STAND — The support for the camera box, arranged to prevent vibration.

CAMERA SWING — A suspended camera stand.

CARBON PROCESS — Method of producing positives in gelatin impregnated with a pigment. Used in photogravure and rotary photogravure.

CAST — Anything formed by pouring, while liquid, into a mold, as plaster into a gelatin mold or stereotype metal into a matrix.

CASTING-BOX — The apparatus used for casting.

CEROGRAPHY — Engraving in wax. Used largely by map engravers.

CHALK PLATE — An engraving made with a steel point through a chalk coating on a steel plate. Afterward cast in stereotype metal.

CHALK ENGRAVING — An engraving made with a steel point through a chalk coating on a metal plate, which is later cast in stereotype metal.

CHEMIGLYPHIC — Engraved by chemical action.

CHEMIGRAPHY — Relief etching on metal.

CHEMITYPE — A zinc plate etched first slightly intaglio, the incisions filled in with fusible metal, after which the zinc is etched in relief.

CHIARAOSCURO — A method of printing engravings from several blocks representing lighter and darker shades.

CHINA WHITE — A very pure variety of white lead.

CHINESE WHITE — A very pure white, made from zinc oxid.

CHROMATIC — Relating to color. Colored.

CHROMATIC ABERRATION — The lack of color correction in a lens.

CHROMOCOLLOTYPE — A collotype printed in colors.

CHROMOLITHOGRAPHY — Lithographic printing in colors.

CHROMOPHOTOGRAPH — A picture produced in colors by photography.

CLICHE'— A French word for negative. Properly a stereotype or electrotype.

COLLOGEN or COLLAGEN — A glue or gelatin.

COLLOID — Substances similar to glue, such as gelatin, dextrin, gum, casein, starch, albumen, caramel, cellulose and tannin.

COLLOTYPE — (In German, *Lichtdruck;* French, *Phototypie*). Known in the United States as Albertype, Artotype, Heliotype and Gelatin Printing. It is a method of printing in the lithographic manner from a sheet of bichromatized gelatin that has been exposed to light under a reversed negative.

COLOR FILTER — Same as Color Screen. Any colored medium by which some colors are excluded when photographing.

COLOR PLATE — One of a set or series of engraved plates, which, combined by printing, produce a picture in colors.

COLOR SCREEN — A color filter.

COLOR-SENSITIZING — The method by which photographic surfaces are rendered sensitive to certain colors, or to all colors equally.

COMB — A steel tool grooved to match half-tone screens and used as a multiple graver.

COMBINATION PLATE — Made by stripping line and half-tone negative films together in a design on the same glass, printing from this combination negative and etching the plate.

COMBINATION PLATES FOR COLOR PRINTING — Those in which a key-plate is used with plates for two or more colors.

COMETS — Spots of dirt on a sensitive plate, which on development take the shape of comets.

CONTACT — Term used when two surfaces are brought absolutely together. When surfaces do not come together it is called "lack of contact."

CONTE PROCESS — A zinc plate is covered with a gum and zinc-white varnish. The design is etched through it with stylus-like points. The whole is inked up with greasy ink and soaked in water, when the gum varnish comes away, leaving the design in greasy ink, which can be either etched in relief or printed from planographically.

CONTINUING ACTION OF LIGHT — Name given to the action that goes on in bichromatized gelatin after it has been exposed to light.

CONTRAST — A requisite in negatives for photomechanical processes where the final result is to be in black-and-white.

CONTRASTY — Term applied to negatives or proofs where the shadows and high lights are strongly indicated.

COPPER ETCHING — A design in lines etched on copper.

COPPERPLATE ENGRAVING — Intaglio engraving, also called line engraving. The lines in the plate are incised either with a burin or corroded with an etching solution.

COPY — Any subject, whether drawing, painting or object, submitted for photomechanical reproduction.

COPY-BOARD — The board to which copy is affixed for photographing.

COPYHOLDER — A sheet of plate glass framed, with a back board, between which and the glass, copy can be held flat while copying.

COPYING CAMERA — Name given to the camera used by processworkers.

COTTON — An abbreviation for guncotton or pyroxylin.

C. P. — Chemically pure.

CRAPE MARKINGS — A defect in collodion which shows itself in the wet process and in collodion emulsion. Named from its resemblance to crape.

CRAYON ENGRAVING — The imitation of crayon drawing by an intaglio plate, the engraving being done with roulettes, points and multiple punches.

CROP — When marked on copy means that the plate is to be cut off at the line marked near the word "crop."

CUT — An abbreviation of woodcut, not applicable to photoengravings, though used for the engravings on newspapers.

CUT-OUT — Name given to a high-light process in which a negative without a screen is used over the glass in the printing frame

to mask or cut out the high lights in the half-tone negative in the frame.

CUTTING — The dissolving away of the fringe of deposit left by the developer around the dots in half-tone negatives.

CYANOTYPE — Name given by Sir John Herschel to blue-print process which he invented.

DAGUERROTYPE — First perfected photographic process, given free to the world January 7, 1839. The photographic image was made on a silver-plated copper mirror.

DARKROOM — Where the operations of handling material sensitive to light is carried on. It can be well illuminated providing the light used is nonactinic.

DARK SLIDE — The English term for plateholder.

DEEP ETCHING — Where additional etching is required.

DEFINITION — In a lens is the property of giving a sharp image on the ground glass.

DENSITY — In photographic language signifies opacity.

DESENSITIZE — Giving stone or metal surfaces a grease-resisting treatment.

DETAIL — A minute part of a negative, picture or print.

DEVELOPER — The agent which renders visible the invisible image.

DEVELOPMENT — The production of a visible image from an invisible or latent one.

DEVILS — Holes which appear in photogravure plates during etching.

DIAPHRAGM — Or stop, used in a lens to increase definition. In half-tone it is used to control the size and shape of the dots.

DIAPOSITIVE — A positive made from a negative.

DIP — Each intensification of a negative is a dip.

DIPPER — The holder for the collodionized glass plate, by which it is lowered and raised from the silver bath.

DIRECT HALF-TONE — When the half-tone negative is made direct from an object and not from a drawing or photograph of it.

DIRECT PROCESS — In color-plate making, when the half-tone negatives are made direct through color screens.

DISTORTION — In an image may come from the lens, lack of parallelism between ground glass and copy, in stripping the negative film, or the carbon film in photogravure.

DRAGON'S-BLOOD — A red resin, supposed to exude from the fruit of the *Calamus Draco,* a rattan palm found in Malay.

DUOGRAPH — Two half-tone plates made from the same copy at different screen angles and printed in two shades of the same color or a strong color and a tint.

DUOTYPE — Two half-tone plates made from the same negative, but etched differently.

DUST GRAIN — An acid-resisting grain produced on a metal plate by allowing powdered resin to fall upon it.

DUSTING-BOX — The apparatus used in producing a dust grain.

DUTCH MORDANT — Etching solution for copper in which chlorate of potash and hydrochloric acid are used.

ELECTRO — Abbreviation of electrotype. An electrotype.

ELECTROENGRAVING — Etching a metal plate by galvanic action.

ELECTROGRAPH — Apparatus used in engraving mechanically copper cylinders for fabric or wall-paper printing.

ELECTROSTEELING — Electroplating engraved copper plates with iron to withstand wear in printing.

ELECTROTINTING — A design is put on a metal plate in an acid-resisting varnish, when it is placed in an electric bath and etched in relief by galvanic action. Electroengraving.

ELECTROTYPE — A duplicate in metal of an engraved or molded surface made by galvanic action and backed up with type metal.

ELECTROTYPE SHELL — The thin metal duplicate made by galvanic action before it is backed up with type metal.

EM — The square of the body of any size of type.

EMBOSSING-PLATE — A plate engraved or etched for the purpose of producing figures or designs in relief.

EMULSION — Gelatin or collodion holding minutely divided silver salts in suspension.

ENAMEL — A coating, on a metal plate, of sensitized glue, albumen, gum, or a mixture of them, on which a photographic image is produced. This is carbonized by heat and becomes a strong acid resist.

ENAMEL PRINT — An image produced on enamel by photography.

ENCLOSED ARC — An electric arc lamp in which the light burns in a partial vacuum, producing violet rays.

ENGRAVE — To cut, incise or etch in a surface, especially for printing purposes.

ENGRAVED HALF-TONE — A half-tone that has been gone over with a burin in the hands of an engraver.

ENGRAVER — One who represents objects by incisions in a surface, either by hand, mechanically or photographically, from which impressions may be taken in printing-ink.

ENGRAVER'S METAL — An alloy similar to type metal, on which engravings or tints can be produced.

ENGRAVER'S PAD — A leather sand-bag on which the engraver rests a plate or block while working on it.

ENGRAVER'S PROOF — A carefully pulled impression in printing-

ink taken from an engraving to show the engraver's work at its best.

ENGRAVING — The act of producing designs on a surface, either in relief or intaglio, for printing purposes. The plate or block that has been either incised or engraved in relief. The impression from an engraved plate.

ENLARGEMENT — A reproduction of a greater size than the original copy.

ENLARGING — Making a larger image from a negative or positive on a sensitive surface.

ENLARGING-CAMERA — A camera specially constructed for making enlargements.

ETCHED NEGATIVE — A negative made by drawing with a needle point through an opaque ground on a glass plate.

ETCHING — The production of an engraving by corrosion with an acid. The plate produced by acid corrosion. The impression in printing-ink from an etched plate.

ETCHING-BATH — The acid solution, mordant or etching fluid used in producing an etching.

ETCHING-GROUND — The coating on a metal plate to protect the surface from the action of the acid.

ETCHING-INK — An ink having special acid-resisting properties.

ETCHING-MACHINE — An apparatus for hastening the action of the etching fluid, usually operated by power.

ETCHING-NEEDLE — A sharp instrument of steel for drawing through an etching-ground. An etching-point.

ETCHING-POINT — An etching-needle.

ETCHING-POWDER — An acid-resisting resin in powder form.

ETCHING-ROOM — The place where etching is done.

ETCHING SOLUTION — The fluid or mordant used in corroding a metal plate.

ETCHING-TUB — A shallow acid-proof box in which metal plates are rocked in the etching fluid.

EVAPORATING-DISH — Used for boiling down the silver bath.

EXPOSURE — The act of submitting a sensitized surface to the action of light.

EXPOSURE METER — An instrument for measuring the strength of light so as to indicate the correct exposure.

FACSIMILE — A reproduction the same size and an exact copy of the original.

FERROPRUSSIATE PAPER — Commonly called blue-print paper.

FERROTYPE — A positive photograph made on a sensitized sheet of iron. Commonly called tintype.

FILM — Any thin skin of gelatin, collodion, albumen, varnish or other liquid remaining after its solvent has evaporated.

FINE ETCHING — Another name for reëtching or staging a half-tone engraving.

FINE LINE — Term applied to the most delicate line in an engraving.

FINISH — The style of treatment given an engraving to complete it, such as "vignetted," "square," "oval," etc.

FINISHER — The engraver who reëtches and retouches an engraving to make it ready for the final proof.

FINISHING-ETCH — The last or deep etch given a metal plate to make the incisions of sufficient depth.

FINISHING-INK — The etching-ink rolled on a plate before the finishing-etch.

FISH GLUE — Glue made from fishes and used in the enamel acid resist.

FIXING — Term applied to the dissolving away of the sensitive salt unacted upon by light.

FLASHING — In half-tone negative-making, the exposure, with a small stop, of the sensitive plate for a short period to white paper.

FLAT — Lack of vigor or contrast in a negative, photograph or print of any kind.

FLAT — Term used for a glass on which several negative films are laid together to save time in printing and etching. The etched plate is also called a flat.

FLATNESS OF FIELD — A quality in a lens most desirable for copying purposes.

FLAT PROOF — An impression taken from a metal plate without underlay or overlay.

FOCUS — A point at which rays of light meet again after diverging from one point and passing through a lens.

FOCUSING — The act of bringing an image to a focus on the ground glass of a camera.

FOCUSING-CLOTH — An opaque cloth used to cover the head and shut out unnecessary light while focusing.

FOCUSING-GLASS — A magnifying glass used on the ground glass to determine when the image is in the sharpest focus.

FOCUSING-SCREEN — The ground glass on which the image is brought to a focus.

FOG — Any veil or discoloration appearing on a negative during development.

FORMULA — A list of the ingredients and their quantities that make up a solution or compound used in processwork.

FOUR-COLOR PLATES — A set of color plates including a gray or black plate.

FOUR-COLOR PROCESS — The method of reproducing objects in color in which four printing-plates are used.

FOUR-WAY POWDERING — Brushing acid-resisting powder in four directions on a plate to protect the raised lines during etching.

FULL-TONE — An engraving made through a screen and containing pure whites and solid blacks besides the half-tones. A high-light half-tone.

GELATIN — A substance which swells in cold water, dissolves in warm water, and solidifies or jellies again when cold.

GELATIN PROCESS — An obsolete photoengraving process in which gelatin was sensitized, exposed to light and swollen into relief, known as the swelled-gelatin process.

GELATIN RELIEF — An image composed of gelatin in relief.

GELATOSE — A glue or gelatin that has its swelling property destroyed. Fish glue. Metagelatin.

GILLOTAGE — The method of etching zinc in which the plate is rolled up with a soft etching-ink between bites. The ink is melted and flows down the sides of the relief line to protect it from the etching-fluid.

GILLOT PROCESS — Invented in Paris in 1859 by Gillot, who transferred from a litho stone to zinc, powdered the transfer with resin and etched it into relief.

GLUED-UP BACKING — Blocking-wood that has been tongued and grooved and cemented together.

GOUPIL PROCESS — Used for making color plates in grain, by an artist, after the image is photographed on the metal plate.

GRAIN — Any fine powder that produces a granular appearance on either a negative or printing plate.

GRAINED PLATE — Any relief printing-plate in which the printing surface is in a grain. Used chiefly on the offset press and in color printing.

GRAINING-BATH — A solution for producing a grain on the surface of a metal plate by chemical means.

GRAINING-MACHINE — Apparatus used to produce a grain on a metal plate.

GRAINING-SAND — The granular cutting material used in producing a grain on a metal plate mechanically.

GRAPHOTYPE — Drawings made on a chalk-covered plate in an ink which hardens the chalk so that the unhardened chalk may be brushed away and the relief thus made stereotyped from.

GRAVER — A tool used for engraving.

GRAY — A photoengravers' term for any print that is not sufficiently dark. A light impression.

GUMMING SOLUTION — Composed of gum arabic chiefly and

used to prevent greasy ink from adhering to a metal plate or litho stone.

HALATION — In a negative is a reflection of light from the back surface of the negative glass.

HALF-TONE — A printing-plate or picture made by the half-tone process.

HALF-TONE, OUTLINED — A half-tone with the background outside of the object entirely cut away, leaving a definite edge without shading or vignetting.

HALF-TONE, OUTLINED AND VIGNETTED — A half-tone in which part of the background is cut away and part vignetted.

HALF-TONE PLATEHOLDER — A light-tight box for holding both the sensitive plate and half-tone screen and inserting them in the camera.

HALF-TONE PROCESS — A photomechanical method of making printing surfaces in which the object is photographed through a grating called a half-tone screen. In German, it is *autotypie;* in French, *similigravure.*

HALF-TONE SCREEN — A grating of opaque lines, usually ruled on glass, through which light from the object passes in photographing for the half-tone process.

HALF-TONE, SQUARE-PLATE — A half-tone in which the outside edges are rectangular and parallel. May be with or without single black line border.

HAND PROOF — A carefully pulled impression of a printing surface.

HAND REST — A rest for the hand while working over a printing surface.

HAND TOOLING — Any work done by use of a tool upon the plate to increase the contrast of the etched plate.

HARDENING BATH — Any solution that toughens a substance. Used to harden gelatin and glue in processwork.

HELIOGRAPHY — The Greek for "sun-drawing," and applied by Niepce to the first photoengraving made.

HELIOGRAVURE — A term used in some countries for "photoengraving."

HELIOTYPE — A collotype process in which metal is used instead of glass to support the gelatin printing surface.

HICKEY — A slang word used by photoengravers for a slight defect in a negative or printing-plate. Named after Jim Hickey.

HIGH LIGHT — The brightest part of a picture. The densest portion of a negative.

HIGH-LIGHT HALF-TONE — A half-tone plate in which the elimination of the dots in the high lights is accomplished by a photomechanical method instead of cutting them out with a tool.

HIGH-LIGHT PROCESS — A half-tone process in which the highest lights appear white in the finished print.

HIGH-LIGHT STOP — The diaphragm used to join up the high lights in half-tone negative-making.

HYDROMETER — An instrument for determining the densities of liquids.

IMAGE — The picture formed on the ground glass of a camera.

INDIA INK — An ink made in China and Japan. Now applied to black drawing-ink.

INDIRECT PROCESS — Term applied to color plate-making when the half-tone negative is not made directly through the half-tone screen and color filter.

INDOTINT — A collotype process in which the gelatin printing film was attached to a sand-blasted copper plate.

INKING IN — Drawing in ink over a photograph or pencil sketch. Sometimes applied to inking an intaglio plate.

INKING-ROLLER — Used for applying a coating of ink to any surface.

INKING UP — Term used for coating any photographic surface with ink after it has been exposed to light.

INK-PHOTO — A collotype process used in England.

INK SLAB — A stone, metal or glass surface on which printing-ink is distributed.

INSIDE MORTISE — An opening cut entirely inside the printing block for the insertion of type or other purposes.

INTAGLIO — An engraving in which the printing lines are sunken instead of being raised.

INTAGLIO ETCHING — Sinking or incising the lines in a plate by the use of a corrosive liquid.

INTAGLIO PLATE — A printing-plate in which the lines are incised or sunken, either by punching, engraving with a burin, or etching.

INTAGLIOTYPE — Intaglio engraving produced by drawing with a special ink on a plate coated with compressed zinc oxid. When the drawing is developed it is stereotyped or electrotyped.

INTENSIFICATION — The act of increasing the opacity of a developed image.

INTENSIFIER — An agent used to increase the opacity of a developed image.

ISOCHROMATIC — Same as orthochromatic. A method of reproducing colors in their relative tone values as regards light and dark.

ISOTYPIE — Name given to half-tones made with diaphragms having more than one opening.

JIG SAW — A reciprocating saw used for cutting inside mortises.

KEY-PLATE — The outline plate, or the one containing most of the design in color printing.

KNURL — The small wheel in a roulette.

LAMINATED BACKING — Mounting or blocking wood consisting of layers of wood glued together, with the grain crossing alternately.

LATENT IMAGE — The invisible picture on a sensitive surface before development.

LAYING DOWN THE TRANSFER — In lithography or planograph work, the act of transferring to the stone or metal plate.

LAYING-DOWN TINTS — Covering surfaces with lines, dots or a grain by tint transfers, shading-mediums, spatterwork, air-brush or resin dust.

LEIMTYPE — The original "wash-out" gelatin process. It produced a hardened gelatin relief which was attached by gutta-percha to a mount and used as a printing-block. Called "photo-electrotype" when the electrotype from it was used to print from.

LENS — Used in photographic work is constructed to bring the visual focus and the actinic focus to the same point.

LEVELING-STAND — Arranged with screws to bring a plate set on it perfectly level. Used in getting a film of gelatin of even thickness.

LICHTDRUCK — The German name for collotype.

LIGHT FILTER — Same as color screen or color filter.

LINE BLOCK — Name given to relief block in lines. A zinc etching.

LINE ENGRAVING — Intaglio engraving executed on the bare metal with gravers or burins. Usually in copper.

LINE DRAWING — A drawing made with pen and ink.

LINEHOLDER — A clamp for holding a small block when trimming its sides on a machine.

LINE NEGATIVE — A negative from a drawing or other copy in lines or stipple.

LINER AND BEVELER — A machine for beveling the edges of a printing-plate and raising a black line around the picture.

LINING-TOOL — An engraving tool with a number of cutting points to match a half-tone screen. Sometimes called "multiple" tool.

LINO CUTS — Engravings on linoleum used in poster work.

LITHOGRAPHY — The art of printing from stone. Printing in a similar manner from metal surfaces is termed "planography."

LITMUS PAPER — Used for testing acidity or alkalinity. Acid turns blue litmus paper red, and an alkali restores the red paper to blue.

MACHINE ETCHING — The modern method of applying an etching fluid to a metal plate instead of the former "tub" etching.

MAKE-READY — Preparing an engraving for proving. The sheet on which the underlays are pasted.

MALE DIE — The relief die in a set of embossing plates.

MASKING — Shading portions of a negative during exposure to light in photographic printing.

MECHANICAL DRAWING — Is made by means of squares, rules and compasses.

MERCUROGRAPHIE — A process based on the fact that mercury amalgamated with the surface of a zinc plate repels ink.

METAGELATIN — Gelatin that has lost its swelling property.

METAL BASE — The type-metal block on which engraved plates are mounted in place of wood.

METAL ENGRAVING — Is applied chiefly to engraving in type metal.

MEZZOGRAPH — A half-tone made by the use of a grained screen instead of a cross-line screen.

MEZZOGRAPH SCREEN — A transparent glass screen having a reticulated surface used to get grain effects in printing surfaces.

MEZZOTINT — A method of engraving in which the surface of the copper plate is first uniformly roughened, and then the effects are produced by scraping away the bur, as it is called, and by burnishing.

MINIMUM — The lowest charge made for engravings. Usually for blocks 10 square inches and smaller.

MODELED PLATE — Half-tone made from a bas-relief in clay, plaster, wax, etc.

MOIRE — The varied pattern obtained when reproducing a half-tone through a half-tone screen. When the screens are not at the proper angles in a set of color plates it also appears.

MORDANT — Any corrosive liquid that can be used as an etching fluid on metal.

MORTISE — To cut away parts of a printing-plate or block that type or other matter may be inserted in it. It can be an "inside" mortise or an "outside" mortise.

MOUNT — The base or support which brings a printing-plate to type height.

MOUNTING — The operation of securing a printing-plate to its mount or base.

MULLER — An implement for grinding ink or graining printing surfaces.

MULTIPLE GRAVER — A graver for cutting several lines at once. A lining tool.

NAILING MACHINE — An improvement on the hand method of securing printing-plates to their mounts or bases.

NAIL-PUNCH — Used to drive the head of the blocking nail below the printing surface.

NATURE PRINTING — A process by which leaves, mosses, feathers, embroideries and the like are pressed into a polished sheet of lead. The lead, indented with their forms, is electrotyped and printed from in a copperplate press.

NEGATIVE — Showing the lights and shades of nature reversed.

NEGATIVE DRYER — A place where negatives are rapidly dried.

NEGATIVE ETCHING — A plate from which the blacks of the original copy will print white and the whites will print black.

NEWSPAPER CUT — The common name for an engraving in a newspaper.

NEWSPAPER HALF-TONE — A half-tone made with a coarse screen suitable for newspaper printing.

NEWS-TONE — A newspaper half-tone.

NEWTON'S RINGS — The colors which appear on a polished metal plate when it is brought into intimate contact with a negative in a printing-frame.

NIELLO — Engraving intaglio and filling up the incisions with black or a permanent color.

NONACTINIC — Light without effect on sensitized surfaces.

NON-ACTINIC — Term applied to the safe light used in darkrooms.

NORMAL STOP — The diaphragm in half-tone negative-making which reproduces the half-tones of the copy.

NOTCHING-MACHINE — Used for cutting outside mortises.

ORIGINAL — That from which duplicates are made. Term sometimes applied to copy of any kind.

ORTHOCHROMATIC — Same as isochromatic.

OUTLINED AND VIGNETTED HALF-TONE — A half-tone in which part of the background is cut away and part vignetted.

OUTLINED HALF-TONE — One with the background cut away.

OUTLINING — Cutting with a graver a line of separation between an object and its background.

OUTSIDE MORTISE — To cut away part of a printing-plate on its outer edge.

OVEREXPOSURE — A term used when a sensitive surface is submitted to the action of light for a longer period than was correct.

OVERLAY — Paper placed over an engraving to increase the impression on certain areas.

OXIDATION — The action of oxygen on the surface of printing-plates, forming oxids or rust.

OYSTER SHELLS — A name that well describes the shapes of blemishes that occur on a wet-plate negative during development.

PAD — The elastic material at the back of the sensitized plate in the printing-frame.

PANCHROMATIC — Sensitive to all colors. Name given to photographic plates.

PANELED BACKING — Mounting lumber with mortised transverse end-pieces for mounting large printing-plates.

PAPYROTINT — A photolithographic process in which the sensitized gelatin paper is reticulated after being printed so that the image upon it is broken up into a grain.

PATENT BLOCK — A mount or support for printing-plates which holds the plate secure by clamps.

PATTERN — Name given to the moire effect when screens or tints are superimposed on one another.

PELLICLE — Any thin film, such as a collodion film, stripped from its glass support.

PEN-AND-INK — Term used for a pen drawing.

PHOTO — An abbreviation of photograph.

PHOTOAQUATINT — A photogravure process in which the resinous grain is deposited by photography.

PHOTOCHROMOLITHOGRAPH — A lithograph in colors, the color separation being made by photography.

PHOTOCHROMOTYPE — A picture in colors printed from relief blocks made from color-separated negatives.

PHOTOCOLLOTYPE — Another name for collotype.

PHOTOCRAYON — A drawing made with a crayon on a ground glass laid over the copy. This ground glass crayon to be afterward reproduced by processwork.

PHOTOELECTROTYPE — An electrotype from a gelatin relief made by photography.

PHOTOENGRAVE — To engrave with the assistance of light.

PHOTOENGRAVER — One engaged in producing engravings through the action of light.

PHOTOENGRAVING — Term applied to the production, by the action of light, of relief blocks for printing in a typographic press. A print from such a block.

PHOTOETCHING — An etching either in relief or intaglio produced by the action of light.

PHOTOFILIGRANE — A photoengraved plate for water-marking paper.

PHOTOGALVANOGRAPHY — Electrotyping from a gutta-percha relief made from bichromatized gelatin exposed to light.

PHOTOGELATIN — Another name for collotype.

PHOTOGLYPHY — Engraving intaglio by photography.

PHOTOGRAVURE — An intaglio photoengraving process which reproduces all the tones of a photograph.

PHOTOLITHOGRAPHY — Producing printing images on stone by photography. Making lithographic transfers by photography.

PHOTOMECHANICAL — A term applied to all processes in which photography is used to aid the printing-press.

PHOTOMETER — An instrument for measuring the intensity of light. An actinometer.

PHOTOPLANOGRAPHY — Photographing on metal plates for surface printing.

PHOTO-PROCESS — Any method of producing printing-plates by photography.

PHOTORELIEF — A photoengraving for use on the typographic press.

PHOTOTYPE — Same as photorelief.

PHOTOXYLOGRAPHY — Photographing on wood.

PHOTOZINCOGRAPHY — Producing images on zinc by photography, either by transfers or direct photoprinting on the metal for planographic printing.

PLANER — A machine for shaving mounts, bases or printing-blocks to a perfect level.

PLANOGRAPHIC PRINTING — Printing from grained metal plates in the lithographic manner. Printing from flat metal surfaces.

PLATE — Term applied to a flat sheet of metal, glass or other material used in photoengraving.

PLATEHOLDER — The dark slide that holds the sensitive plate between darkroom and camera.

PLATE PLIERS — Pliers with wide nose to grip the edge of the metal plate when heating it.

PLATE PRINTING — Taking impressions from an intaglio plate.

PLAYERTYPE — A negative on bromid paper produced by contact with the copy in a printing-frame.

POLYCHROMATIC — Containing many colors. Sensitive to many colors.

POSITIVE — A picture in which the lights and shades are as in nature. In printed matter when it is dark on light paper. The opposite of negative.

POWDER — Name given to the finely ground etching resist.

POWDER BOX — The receptacle for the etching powder or powdered resin used as an acid resist.

POWDERING BRUSH — A brush for removing the surplus etching powder from a plate.

POWDERING FOUR WAYS — The act of brushing etching pow-

der from four directions against the sides of lines or dots on a plate.

PRINT — The image produced in a printing-frame.

PRINTING — In photoengraving is the operation of getting an image from a negative or positive on a surface sensitive to the action of light.

PRINTING-FRAME — The frame used in photoengraving to hold the negative or positive in intimate contact with the sensitized surface during the exposure to light.

PRINTING-LAMP — The light used before a printing-frame.

PRISM — A triangular block of glass used to produce reversed negatives.

PROCESS BLOCKS — Any relief printing-plate produced by photoengraving.

PROCESS CAMERA — A camera used by photoengravers.

PROCESS LENS — One giving sharp definition, having a flat field and corrected for chromatic aberration.

PROCESSWORK — Includes all the operations used in photoengraving and photomechanical printing.

PROOF — A printed impression taken from a printing surface.

PUNCH — A sharpened center-punch for puncturing a printing-plate where the blocking nails are to be inserted.

QUADRICHROMATIC — Composed of four colors.

QUADRICOLOR — Photochromotypes in which four plates are used. Usually the yellow, red and blue, with the addition of a black, brown or gray.

RACK — A stand for draining and drying negatives, or for holding plates of any kind.

REBITE — To recover an engraved plate with an etching ground and reetch it.

REDUCER — A solution used to reduce the density of a negative or reduce the width of opaque lines or dots.

REDUCING — The act of dissolving away some of the opaque parts of a negative. Called in half-tone negative-making "cutting."

REDUCING-GLASS — A double concave glass through which to view a picture to estimate its appearance on reduction.

REDUCTION — A reproduction of a picture or object smaller in size. The method of reducing it.

REETCHING — Same as rebiting or staging.

REGISTER — In color reproduction is the making of the different color plates exactly the same dimensions, so that in printing the impressions from them will coincide perfectly.

REGISTER MARKS — Small crosses or points left on the different color plates, which when superimposed in printing produce register.

REPRODUCTION — Making a copy by processwork.

RESIDUE — Waste material containing a valuable proportion of silver.

REVERSED NEGATIVES — Have the image reversed as regards right and left. Negatives made through a prism or through the glass support.

REVERSED TRANSFERS — Are used on the offset press, and are reversed as regards right and left.

REVERSING MIRROR — Used in place of a prism for producing a reversed negative.

ROLLING UP — Coating a sensitized or printing surface with ink from a roller prior to development, powdering or etching.

ROTARY COPY-BOARD — A revolving copy-board used in color plate-making to get the copy at different angles in relation to the half-tone screen.

ROTARY SCREENHOLDER — A device in color plate-making for rotating the screen in the plateholder.

ROUGH PROOF — An impression taken from a plate without much care.

ROULETTE — An engraver's tool containing a little wheel called a knurl, and used to lighten shades in a relief plate and darken parts in an intaglio engraving.

ROUTER — A machine for removing the parts in the printing-plate not wanted in the impression. The operator on such a machine.

SANDPAPERING-MACHINE — Used to take the rough edges from wooden mounting-blocks.

SATURATION — When a liquid has taken up all possible of a solid.

SCRAPER — A steel blade for removing blemishes in a plate before etching. The part of a hand lithographic press which produces the impression.

SCREENY NEGATIVE — One in which the lines of the screen are unnecessarily conspicuous.

SCUM — Dirt on the surface of a solution. Ink, resin powder, or anything which sticks to a surface and prevents its being etched.

SENSITIZING — Rendering anything sensitive to the action of light.

SEPARATION — In color-record negative-making the dividing of the primary color-records on to separate negatives.

SHADING-MACHINE — Used for laying down tints, dots, grains, stipples or other textures on printing-plates before etching.

SHADOW STOP — The small diaphragm used in half-tone negative-making to produce white dots in the deep shadows.

SHEARS — A guillotine for cutting metal plates.

SHOOT-BOARD — A device with a plane for squaring the sides of blocks.

SHOULDER — The ledge which is left in etching at the sides of a relief line or dot.

SIMILIGRAVURE — French term for half-tone engraving.

SILVER PRINT — A photographic print made without toning on a plain mat paper in chlorid of silver.

SLUG — Photoengravers' slang term for a hole or scratch in a negative film.

SOFT — A print giving all possible detail, both in the high lights and shadows. The opposite to contrasty.

SPENCER ACID — A mordant for etching steel.

SQUARE HALF-TONE — A half-tone when finished whose outer edges are a rectangle. Usually with a black outline.

SQUARE INCH — The basis by which photoengravings are measured.

STAGING — A method by which an etcher stops out certain areas in a plate and continues the etching of others so as to produce contrasts.

STAMPING-DIE — A relief plate engraved on brass or zinc for stamping book-covers or similar surfaces.

STANNOTYPE — A modification of Woodburytype, in which an electrotype is substituted for the lead plate.

STILL-ETCHING — Etching without movement of the etching fluid. Usually with the plate face down.

STOP — Another name for diaphragm.

STOPPING DOWN — Decreasing the aperture in the lens.

STOPPING OUT — In etching, the covering up of certain portions of the plate with an acid-resisting varnish to prevent further etching of the parts so covered. Staging.

STRIPPING — Removing a photographic film from its glass support and placing it upside down on another support.

SUBSTRATUM — A coating on a glass plate to make the collodion adhere to it. Used also on metal to make gelatin and other coatings adhere.

SWEATING — Soldering a metal plate to a metal body by using solder foil between the plate and base and then applying heat and pressure.

SWELLED-GELATIN PROCESS — An early photoengraving process in which a thick film of bichromatized gelatin was exposed to light under a negative. The gelatin unacted upon by light swelled up in cold water. A cast was taken from it in wax, a mold in plaster, and then a cast in type metal.

THREE-COLOR PROCESS PLATES — Printing-plates produced from colored copy or objects to reproduce the picture or object

in its original colors by a photochemical separation of the primary colors, and etched half-tone plates to reproduce each separate color, usually printed in yellow, red and blue. An approximate result may be obtained from one-color copy by using the skill of the workmen in securing the color values on the etched plates.

THREE OR MORE COLOR HALF-TONES — Same as definition of two-color half-tone, using three or more etched half-tone plates.

TINT-BLOCK — A plate engraved in lines, dots or solid, to be printed in a faint color under an illustration.

TINTYPE — A photograph on sheet iron. Should be ferrotype.

TOOL — Shop term for finishing a plate with a graver or burin.

TOP — The acid resist on the surface of the metal plate.

TOPPING POWDER — The first powder used as an acid resist.

TRANSFER — A print in transfer ink pulled either from an intaglio or relief engraving, or made by photolithography.

TRANSFER INK — An ink containing grease, wax, resin, bitumen or any acid-resisting substances used as an etching ground or in transferring pictures to stone or metal.

TRANSFER PAPER — Paper coated with a size of starch, gelatin, dextrin or similar substances on which a print is made in transfer ink for laying down on stone or metal.

TRICHROMATIC — Composed of three colors.

TRIMMER — A machine for accurately dressing the sides of printing-blocks.

TUSCHE — A transfer ink for use with a pen or brush in lithography or planography.

TWO-COLOR HALF-TONE — Two half-tone plates, either or both plates an etched plate containing parts of the original design, to be printed in two contrasting colors.

TYPE-HIGH GAUGE — A device for determining whether a printing-block is exactly the height of type.

TYPOGRAVURE — French name for photoengraving in relief.

UNDERCUT — When the etching fluid has eaten beneath the edge of the printing surface.

UNDEREXPOSE — When the action of light on a sensitized surface has been insufficient.

UNDERLAY — Pieces of paper or other material used under a printing-plate to improve the quality of the impression.

U. S. P. — Abbreviation for United States Pharmacopœa.

VACUUM PRINTING-FRAME — One in which the air is withdrawn from between the plate-glass front and a sheet-rubber back so that the atmospheric pressure on the negative and sensitized sheet is about fifteen pounds to the square inch.

VIGNETTE — An engraving having a background that shades off to nothing.

VIGNETTED HALF-TONE — A half-tone in which one or more of the edges of the object are shaded from dark tones to pure white.

VIGNETTING HAMMER — A tool with a roughened face for beating down the hard edges of an engraving so that it will print as a vignette.

WASH DRAWING — A drawing made with a brush in a single water-color.

WASHOUT PROCESS — A name for "Leimtype," which see.

WATER-COLOR — A picture made in colors soluble in water. An aquarelle.

WAX ENGRAVING — Drawing with a needle point and pressing characters into a film of wax on a metal support. This is afterward electrotyped to form a printing-plate. Most useful in engraving maps and diagrams.

WET COLLODION — Name given to the collodion and silver bath method of making negatives. The plate so sensitized being exposed in the camera while wet.

WET PLATE — Term for wet collodion process to distinguish from dry plate.

WHIRLER — An apparatus for revolving a plate horizontally in order to spread a solution evenly on its surface.

WHITE LINE — A style of wood engraving in which the effects are obtained by white lines instead of cutting around black lines.

WOOD BASE — A support or mount of hard wood for the printing-plate.

WOODBURYTYPE — A picture in pigmented gelatin printed from a lead mold; the latter produced by a photomechanical process.

WOODCUT — An engraving on wood. Properly a wood engraving.

WOOD ENGRAVER — One who engraves on wood.

WOOD ENGRAVING — The art of engraving on wood. A wooden block so engraved. An impression from a wood engraved block.

XYLOGRAPHY — The original name for wood engraving.

ZINC ETCHING — A relief printing-plate engraved on zinc by etching fluids.

ZINC HALF-TONE — A relief printing-plate made from a half-tone negative on zinc.

ZINC HOOK — A steel tool for cutting zinc or other metal sheets by hand.

ZINCO — English term for a zinc etching.

ZINCOGRAPH — A photoengraving on zinc.

ZINCOGRAPHY — The process of producing a photoengraving on zinc.

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